Appendil IV-A

DRAFT
AIR QUALITY MANAGEMENT PLAN
1988 REVISION

DRAFT
APPENDIX IV—A
TIER I AND TIER II
CONTROL MEASURES

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
JUNE 1988

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TABLE OF CONTENTS

| | PART I | PAGE |
|--------|---|------|
| | TIER I CONTROL MEASURES | |
| INTROD | UCTION | I-1 |
| FORMA | T OF CONTROL MEASURES | I-1 |
| DESCRI | PTION OF CONTROL MEASURES | I-3 |
| | STATIONARY SOURCES | |
| SURFAC | CE COATING AND SOLVENT USE | A-1 |
| A-1 | Further Emission Reductions from Wood Flatstock Coating,[ROG] | A-4 |
| A-2 | Further Emission Reductions from Manufactured Wood Furniture and Miscellaneous Wood Products Coating, [ROG] | A-6 |
| A-3 | Further Emission Reductions from Can and Coil Coating, [ROG] | A-10 |
| A-4 | Further Emission Reductions from Aerospace Assembly and Component Coating, [ROG] | A-13 |
| A-5 | Further Emission Reductions from Automobile Assembly Coating, [ROG] | A-16 |
| A-6 | Substitute Solvents Used in Automobile Refinishing, [ROG] | A-19 |
| A-7 | Substitute Solvents Used for Marine Vessel Coating, [ROG] | A-24 |
| A-8 | Control of Emissions from Architectural Coatings, [ROG] | A-27 |
| A-9 | Further Emission Reductions from Paper, Fabric, and Film Coating, [ROG] | A-31 |
| A-10 | Further Emission Reductions from Graphic Art Operation, [ROG] | A-34 |
| A-11 | Substitute Solvents Used for Clean-up of Surface Coating, [ROG] | |

| | PART I | | PAGE |
|--------|---|--------|------|
| A-12 | Further Emission Reductions from Metal Cleaning and Degreasing, [ROG] | | A-40 |
| A-13 | Control of Emissions from Rigid and Flexible Disc Manufacturing Operation, [ROG] | | A-46 |
| A-14 | Control of Emissions from Expanding Plastics and Blowing Foam Manufacturing Operation, [ROG] | | A-48 |
| A-15 | Control of Emissions from Semiconductor Manufacturing Operation, [ROG] | | A-51 |
| A-16 | Further Emission Reductions from Perchloroethylene Dry Cleaning Operation, [ROG] | | A-54 |
| A-17 | Further Emission Reductions from Petroleum Dry Cleaning Operation, [ROG] | | A-58 |
| A-18 | Control of Emissions from Underarm Products, [ROG] | | A-61 |
| A-19 | Control of Emissions from Domestic Products, [ROG] | | A-64 |
| A-20 | Control of Emissions from Solvent Waste, [ROG] | | A-67 |
| A-21 | Further Emission Reductions from Adhesives, [ROG] | | A-71 |
| PETROL | EUM AND GAS PRODUCTION | | B-1 |
| B-1 | Control of Emissions from Gasoline Transfer: Fail Safe Phase-I Vapor Recovery Systems, [ROG] | | B-4 |
| B-2 | Control of Emissions from Gasoline Transfer: Improved Installation and Repair of Phase-II Vapor Recovery Systems, [ROG] | | B-8 |
| B-3 | Control of Emissions from Open Sumps, Pits, and Wastewater Separators, [ROG] | •••••• | B-11 |
| B-4 | Control of Emissions from Pleasure Boat Fueling Operations, [ROG] | | B-14 |

| | PART I | PAGE |
|-------|--|--------|
| B-5 | Control of Emissions from Cyclic Steam Production Wells, [ROG] | B-17 |
| B-6 | Control of Emissions from Crude Oil Pipeline Heaters, [NO _X] | . B-21 |
| B-7 | Control of Emissions from Petroleum Refinery Fluid Catalytic Cracking (FCC) Units, [SO _X] | B-24 |
| B-8 | Control of Emissions from Petroleum Coke Calcining Operations, [SO _X] | B-27 |
| B-9 | Control of Emissions from Gas Fired Petroleum Refinery Process Heaters, [PM] | B-29 |
| B-10 | Improved Control of Emissions from Petroleum Refinery Fluid Catalytic Cracking (FCC) Units, [PM] | B-32 |
| B-11 | Control of Emissions From OCS Exploration, Development, and Production, [All Pollutants] | B-35 |
| B-12 | Control of Emissions From Petroleum Refinery Flares, [All Pollutants] | B-39 |
| B-13 | Further Emission Reductions from Valves, Pumps, and Compressors Used in Oil and Gas Production Fields, Refineries and Chemical Plants, [ROG] | B-43 |
| B-14 | Control of Emissions from Oil Field Steam Generators, [NO _X] | B-49 |
| B-15 | Control of Emissions from Petroleum Refinery Heaters and Boilers, [NO _X] | B-52 |
| COMME | RCIAL AND INDUSTRIAL PROCESSES | C-1 |
| C-1 | Control of Emissions from Large Commercial Bakeries,[ROG] | C-3 |
| C-2 | Control of Emissions from Breweries, [ROG] | |
| C-3 | Control of Emissions from Commercial Charbroiling,[ROG,PM] | |

| | PART I | PAGE |
|-------|---|------|
| C-4 | Further Emission Reductions from Rubber Products Manufacturing, [ROG,PM] | |
| C-5 | Further Emission Reductions from Unconfined Abrasive Blasting Operations, [PM] | |
| C-6 | Control of Emissions from Woodworking Operations, [PM] | |
| C-7 | Control of Emissions from Small Boilers and Process Heaters, [NO _X] | C-26 |
| C-8 | Control of Emissions from Industrial, Institutional, and Commerical Boilers, Steam Generators, and Process Heaters [NO _X] | |
| C-9 | Control of Emissions from Stationary Gas Turbines, [NO _X] | |
| C-10 | Control of Emissions from Electric Power Generating Boilers, [NO _X] | |
| C-11 | Control of Emissions from Afterburners, [NO _X] | |
| C-12 | Control of Emissions from Non-Utility Internal Combustion Engines,[All Pollutants] | |
| RESID | ENTIAL AND PUBLIC SECTORS | D-1 |
| D-1 | Control of Emissions from Starter Fluid, [ROG] | D-3 |
| D-2 | Application of Solar Panels on Residential Water Heaters, [NO _X] | D-6 |
| D-3 | Application of Heat Transfer Modules on Residential Heating Furnaces, [NO _x] | D-9 |
| D-4 | Addition of Flue Dampers on Residential Water Heaters, [NO _X] | D-11 |
| D-5 | Out-of-Basin Transportation of Biodegradable Solid Waste, [All Pollutants] | D-14 |
| D-6 | Control of Fugitive Emissions from Publicly Owned Treatment Works, [ROG] | D-18 |

| | PART I | PAGE |
|--------|--|------|
| D-7 | Control of Emissions from Utility Equipment, [All Pollutants] | D-21 |
| AGRICU | LTURAL PROCESSES | E-1 |
| E-1 | Control of Emissions from Pesticide Application, [ROG] | E-3 |
| E-2 | Control of Emissions from Livestock Waste, [ROG,PM,NH ₃] | E-7 |
| E-3 | Control of Fugitive Dust from Agriculture, [PM] | E-14 |
| OTHERS | | F-1 |
| F-1 | Installation of Best Available Retrofit Control Technology, [All Pollutants] | F-3 |
| F-2 | Uniform Commercial Quality Standard on Sulfur Content of Gaseous Fuels, [SO _x] | F-6 |
| F-3 | Lower Limits on Sulfur Content of Stationary Liquid Fuels, [SO _x] | F-11 |
| F-4 | Control of Fugitive Emissions from Construction of Roads and Buildings, [PM] | F-15 |
| F-5 | Control of Ammonia Emissions from Stationary Sources by Permits and Fees, [NH ₃] | F-18 |
| F-6 | Control of Emissions from Exempt Equipment, [All Pollutants] | F-20 |
| F-7 | Control of Emissions from Soil Decontamination, [ROG] | F-22 |
| F-8 | New Source Reveiw [All Pollutants] | |
| F-9 | Low Emission Methods and Materials for Building Construction, [PM] | |
| F-10 | Phase-Out Stationary Source Fuel Oil and Solid Fossil Fuel Use, [ROG] | |

| | PARTI | PAGE |
|---------|---|------|
| | TRANSPORTATION SOURCES | |
| MOTOR | VEHICLES | G-1 |
| G-1 | Urban Bus System Electrification, [All Pollutants] | G-3 |
| G-2 | Clean Fuel Retrofit of Transit Buses, [NO _X , SO _X , PM] | G-6 |
| G-3 | Use of Radial Tires on Light Duty Motor Vehicles, [PM] | G-9 |
| G-4 | Clean Fuels In New Fleet Vehicles [All Pollutants] | G-11 |
| TRANSP | ORTATION SYSTEM AND LAND USE | H-1 |
| H-1 | Disincentives for Idling at Drive-Through Facilities, [ROG, NO _X , CO] | H-3 |
| H-2 | Limitations on Vehicle Registration, [All Pollutants] | H-5 |
| OFF ROA | AD VEHICLES | I-1 |
| I-1 | Control of Emissions from Ship Berthing Facilities, $[NO_x]$ | I-3 |
| I-2 | Control of Emissions from Jet Aircraft Engines, [ROG, CO,NO _X] | I-6 |
| I-3 | Control of Emissions from Marine Vessel Tanks, [ROG] | I-10 |
| I-4 | Control of Emissions from Marine Diesel Operations,[NO _X] | I-17 |
| I-5 | Limit on Sulfur Content of Marine Fuel Oils, [SO _X] | I-21 |
| I-6 | Control of Emissions from Pleasure Boat, [ROG,NO _X] | I-26 |
| I-7 | Control of Emissions from Switching Locomotives, [All Pollutants] | I-30 |

| PART II | PAGE |
|---------------------------------|-------|
| TIER II CONTROL MEASURES | |
| INTRODUCTION | II-1 |
| TRANSPORTATION SECTOR | II-3 |
| SURFACE COATING AND SOLVENT USE | II-6 |
| STATIONARY SOURCES | II-10 |
| SUMMARY | II-10 |

LIST OF TABLES

| TABLE | | <u>PAGE</u> |
|-------|---|-------------|
| | PART I - TIER I CONTROL MEASURES | |
| I-1A | Conversion of DCF Cost Effectiveness Values at 4% Real Interest Rate and 10 years Econ. Life to LCF Cost Values at 4% Real Interst and 10 years Econ. Life | I-3 |
| I-1B | Conversion of DCF Cost Effectiveness Values at 4% Real Interest Rate and 10 years Econ. Life to LCF Cost Values at 10% Real Interst and 10 years Econ. Life | I-6 |
| I-2A | Surface Coating and Solvent Use | A-2 |
| I-2B | Petroleum and Gas Production | B-2 |
| I-2C | Commerical and Industrial Processes | C-2 |
| I-2D | Residential and Public Sectors | D-2 |
| I-2E | Agricultural Processes | E-2 |
| I-2F | Others | F-2 |
| I-2G | Motor Vehicles | G-2 |
| I-2H | Transportation System and Land Use | H-2 |
| I-2I | Off Road Vehicles | I-2 |
| | PART II - TIER II CONTROL MEASURES | |
| II-1 | Tier II Control Goals | II-2 |
| II-2 | Tier II Emission Reductions | II-14 |
| II-3 | Cummulative Emission Reductions From Tiers I and II Measures | II-14 |

LIST OF ACRONYMS AND ABBREVIATIONS

ARB California Air Resources Board

CO Carbon Monoxide

HDT Heavy Duty Trucks

LDA Light Duty Automobile

LMDT Light And Medium Duty Trucks

MW Mega Watt

NH₃ Ammonia

NO_v Oxides Of Nitrogen

PM Particulate Matter

PM₁₀ Particulate Matter (<10 microns)

ROG Reactive Organic Gases

SCAG Southern California Association

Of Governments

SCAQMD South Coast Air Quality Management

District

SCR Selective Catalytic Reduction

SNCR Selective Non-Catalytic Reduction

SO_x Oxides Of Sulfur

T/D Tons Per Day

TOG Total Organic Gases

VMT Vehicle Miles Travelled

VOC Volatile Organic Compound

PART ONE

TIER ONE CONTROL MEASURES

Introduction
Format of Control Measures
Description of Control Measures



INTRODUCTION

Part One of this appendix contains the Tier I control measures included for the 1988 AQMP Revision. These measures are based upon technological applications currently available and which can be implemented within the next five years. Many of the proposed measures were developed in the District's 1979 and 1982 AQMPs," Working Paper No.4: Short-Range Control Measures," and the "Path to Clean Air". The Tier I control measures presented in this report are divided into two major impacted sectors: stationary sources and transportation sources. Stationary sources contain six subgroups: surface coating and solvent use, petroleum and gas production and distribution, industrial and commercial processes, residential and public sectors, agricultural processes, and others. Transportation sources contain three subgroups: motor vehicles, transportation system and land use, and off road vehicles. Tier I control Measures developed by SCAG and ARB are contained in the Appendix IV-G and Appendix IV-F of the 1988 AQMP Revision, respectively.

FORMAT OF CONTROL MEASURES

Included in each control measure description is a title, summary table, description of source category, proposed method of control, estimated emissions reduction, cost effectiveness, other impacts, and references. The type of information that can be found under each of these subheadings is described below.

Title- The title contains the control measure name, the major pollutant(s) controlled by the measure, and a designated control series number. When a control measure is currently under rule development or has been adopted in the Board approved Early Action Plan, an asterisk is added to the series number.

Summary Table- A summary table highlights the major findings contained in the text of a control measure write-up.

Description of Source Category- The description provides information on the source of emissions and the intent of the control measure. Under the subheading "Background", information such as number of sources in the Basin, description of emission sources, and pollutant(s) of concern is provided. Under the subheading, "Regulatory History", information on existing regulatory control and current regulatory development by associated agencies is summarized.

Proposed Method of Control- This subsection briefly describes the level of control proposed by the control measure. If specific technological application(s) are involved, this section also provides information on the technical status, expected performance, and current applications.

Emissions Reduction- In this section, the uncontrolled emissions for the affected category for the years 1985, 2000, and 2010 are shown (See Appendices III-A and III-B). The emission reductions due to implementation of the District rules adopted between 1985 and 1988 are reflected in years 2000 and 2010 emission projections. Based on the expected control efficiency specified in the previous section, potential emission reductions are calculated for 2000 and 2010, assuming the control measure is fully implemented by then in the absence of other competing control measures. If the control efficiency is provided in a range, the midpoint is selected to calculate the emission reductions.

Cost Effectiveness- The Discounted Cash Flow (DCF) method is used to calculate cost effectiveness of each control measure. The cost analysis is in 1987 dollars. Table I-1 shows the correspondence between DCF and LCF (Levelized Cash Flow) methods. The LCF method had been used in the past AQMPs to estimate costs for all control measures. The general cost analysis methodology and assumptions can be found in Appendix IV-D of the 1988 AQMP Revision.

Other Impacts- This section describes any other associated impacts with implementation of the proposed measure, such as jurisdictional authority, economic, social and other environmental impacts (e.g., noise, water, solid waste, and toxic waste). The implementation schedule, along with the implementing agency, are summarized in

CONVERSION OF DCF COST EFFECTIVENESS VALUES AT 4% REAL INTEREST RATE AND 10 YEARS ECON. LIFE TO

LCF COST VALUES AT 4% REAL INTEREST AND 10 YEARS ECON. LIFE (a,b)

| | CONTROL MEASURE | DC | F C/E PER TON REDUC | CTION OF | LC | F C/E PER | TON REDU | CTION OF |
|---------|--|----------|---------------------|----------|----------|-----------|----------|----------|
| NUMBER | DESCRIPTION | ROG | NOX SOX | PM | ROG | N | OX S | OX PM |
| EARLY A | CTION MEASURES | | | | | | | |
| A-2 | WOOD FURNITURE AND MISC WOOD COATINGS | \$4,900 | | | \$6,000 | | | |
| A-6 | SUBSTITUTE COATINGS & SOLVENTS, AUTO REFINISHING | \$2,100 | | | \$2,600 | | | |
| A-7 | SUBSTITUTE COATINGS FOR MARINE VESSELS | \$2,000 | | | \$2,500 | | | |
| A-11 | SUB CLEAN-UP SOLVENTS FOR SURFACE COATING | \$1,100 | | | \$1,400 | | | |
| A-12 | METAL SOLVENT CLEANING & DEGREASERS | \$10,000 | | | \$12,300 | | | |
| A-15 | SEMICONDUCTOR MANUFACTURING | \$2,300 | | | \$2,800 | | | |
| B-13 | VALVES, PUMPS & COMPRESSORS | \$15,000 | | | \$18,500 | | | |
| B-15 | REFINERY BOILERS AND HEATERS | | \$6,600 | | | \$8,100 | | |
| C-8 | INDUSTRIAL BOILERS | | \$6,800 | | | \$8,400 | | |
| C-9 | GAS TURBINES | | \$15,500 | | | \$19,100 | | |
| C-10 | UTILITY BOILERS | | \$25,700 | | | \$31,600 | | |
| F-7 | SOIL DECONTAMINATION | \$36,700 | | | \$36,700 | | | |
| I-1 | SHIP BERTHING | | \$25,300 | | | \$31,100 | | |
| ADDITI | ONAL CONTROL MEASURES FOR STATIONARY SOURCES | | | | | | | |
| A-9 | PAPER, FABRIC AND GLASS COATING | \$5,000 | | | \$5,000 | | | |
| A-4 | AEROSPACE ASSEMBLY COATINGS | Savings | | | | | | |
| A-5 | AUTOMOBILE ASSEMBLY COATING | \$19,000 | | | \$23,400 | | | |
| A-13 | DISC MANUFACTURING | \$3,300 | | | \$4,100 | | | |
| A-14 | EXPANDED PLASTICS AND BLOWING FOAM | \$2,100 | | | \$2,600 | | | |
| A-16 | PERC DRY CLEANING | \$3,000 | | | \$3,700 | | | |
| A-17 | PETRO DRY CLEANING | \$2,000 | | | \$2,500 | | | |
| A-18 | UNDERARM PRODUCTS | \$400 | | | \$500 | | | |
| B-2 | IMPROVED VAPOR RECOVERY INSTAL. & REPAIR | \$110 | | | \$120 | | | |
| B-3 | SUMPS, PITS, & WASTEWATER SEPARATORS | \$2,900 | | | \$3,600 | | | |
| B-4 | BOAT GASOLINE REFUELING OPERATIONS | \$1,200 | | | \$1,500 | | | |
| 8-5 | CYCLIC STEAM PRODUCTION WELLS | \$3,800 | | | \$4,700 | | | |
| B-6 | CRUDE OIL PIPELINE HEATERS | | \$4,000 | | | \$4,900 | | |
| B-7 | FCC FLUE GAS DESULFURIZATION | | \$30,000 | | | | \$36,900 | |
| B-9 | REFINERY GAS FIRED PETRO HEATERS | | | \$12,000 | | | | \$14,800 |
| B-10 | REFINERY FCC UNITS | | | \$29,300 | | | | \$36,000 |

CONTROL MEASURES FOR STATIONARY SOURCES (TIER 1) CONTINUED

| | CONTROL MEASURE | D | CF C/E PE | R TON RED | UCTION OF | LCF | C/E PER | TON REDUC | TION OF |
|--------|---|----------|-------------|-----------|-----------|----------|-----------|-----------|----------|
| NUMBER | DESCRIPTION | ROG | NOX | SOX | PM | ROG | NOX | SOX | PM |
| | | | | | | | | | |
| 0.11 | **OSS EVELODATION DENEMONE PROPERTY | | | | | | | | |
| B-11 | **OCS EXPLORATION, DEVELOPMENT, PRODUCTION | \$24,800 | , , , , , , | | | \$30,500 | \$19,900 | | |
| B-14 | OILFIELD STEAM GENERATORS | | \$4,000 | | | | \$4,900 | | |
| C-1 | COMMERCIAL BAKERY FUGITIVE EMISSIONS | \$4,400 | | | | \$5,400 | | | |
| C-2 | BREWERY FUGITIVE EMISSIONS | \$20,000 | | | | \$24,600 | | | |
| C-3 | **COMMERCIAL CHARBROILING | \$25,000 | | | \$6,200 | \$30,800 | | | \$7,600 |
| C-7 | SMALL INDUSTRIAL BOILERS | | \$24,000 | | | | \$29,500 | | |
| C-4 | RUBBER PRODUCT MFG PROCESSES | \$5,600 | | | \$2,500 | \$6,900 | | | \$3,100 |
| C-5 | UNCONFINED ABRASIVE BLASTING | | | | \$37,800 | · | | | \$46,500 |
| C-6 | WOODWORKING DUST CONTROL SYSTEM | | | | \$12,000 | | | | \$14,800 |
| C-11 | NOX-OUT TECHNOLOGY ON AFTERBURNERS | \$62,200 | | | , | \$76,300 | | | , |
| C-12 | **STAT. NON-GENER I/C ENG. & TURBINES | \$48,200 | \$14,000 | | | \$59,300 | \$17,200 | 1 | |
| D-2 | DOMESTIC SOLAR WATER HEATER RETROFIT | • | \$530,000 | | | , | \$652,000 | | |
| D-3 | HEAT TRANSFER MODULES ON NEW GAS CENTRAL FURN | ACES | \$41,500 | | | | \$51,000 | | |
| D-4 | FLUE GAS DAMPERS ON NEW HOME WATER HEATERS | Savings | | | | | , | | |
| D-7 | **, ***UTILITY EQUIPMENT | \$1,000 | | | | \$1,200 | | | |
| E-1 | PESTICIDE FORMULATION AND USE | \$1,300 | | | | \$1,600 | | | |
| E-2 | LIVESTOCK WASTES | \$1,800 | | | | \$2,200 | | | |
| F-1 | INSTALLATION OF BARCT | | \$24,500 | \$18,300 | \$5,300 | \$21,500 | \$30,100 | \$22,500 | \$6,500 |
| F-2 | SULFUR CONTENT OF GASEOUS FUELS | | | \$20,000 | | | | \$24,600 | |
| F-3 | SULFUR CONTENT OF LIQUID FUELS | | | \$25,000 | | | | \$30,800 | |
| F-4 | CONSTRUCTION OF ROADS AND BUILDINGS | | | , | \$9,300 | | | | \$11,400 |
| , 4 | CONTINUE TO MANDE WITH DOLLD THE | | | | , | | | | |

| | CONTROL MEASURE | DCF | C/E PER T | ON REDUCTI | ON OF | LCF C/I | E PER TON RE | DUCTION (| OF |
|--------|--|----------|-----------|------------|-------|----------|--------------|-----------|----|
| NUMBER | DESCRIPTION | ROG | NOX | SOX | PM | ROG | NOX | SOX | PM |
| G-3 | RADIAL TIRES TO REPLACE BIAS-PLY TIRES | Savings | | | | | | | |
| H-2.2 | RIDE-SHARING | | | | | | | | |
| | | Savings | | | | | | | |
| 1-1 | SHIP BERTHING FACILITIES | \$ | 25,300 | | | | \$31,000 | | |
| 1-2 | NEW JET AIRCRAFT | \$800 | | | | \$800 | | | |
| 1-3 | MARINE VESSEL TANKS-HSKPG | \$1,800 | | | | \$1,800 | | | |
| 1-4 | MARINE DIESEL OPERATIONS | | \$5,400 | | | | \$6,640 | | |
| 1-5 | MARINE FUEL OILS | | | \$3,000 | | | \$3 | ,000 | |
| I-6 | NEW PLEASURE BOATS-2STK | \$4,400 | | | | \$5,400 | | | |
| | NEW PLEASURE BOATS-4STK | \$37,100 | | | | \$45,600 | | | |

Footnotes:

- a. Measures, whose cost effectiveness values were not estimated, are not included in the table.
- b. Figures presented are average C/E values.
- ** Within these source Categories, the recommended control technique reduces several pollutants simultaneously; (e.g., in OCS development, electrification reduces NOX and ROG together.) Within such categories, the C/E analyses ignored pollutants with reductions of less than 1 ton/day.)
- *** In this category, the C/E analyses combined ROG reductions and CO reductions at a 1 :: 10 ratio.

CONVERSION OF DCF COST EFFECTIVENESS VALUES AT 4% REAL INTEREST RATE AND 10 YEARS ECON. LIFE TO LCF COST VALUES AT 10% REAL INTEREST AND 10 YEARS ECON. LIFE (a,b)

| MIMPER | CONTROL MEASURE | DC | F C/E PER | TON REDU | CTION OF | LCI | F C/E PER | TON REDU | CTION OF |
|---|--|--|-----------|----------|------------------|--|-----------|----------|----------|
| UMBER | DESCRIPTION | ROG | NOX | SOX | PM | ROG | NO | OX SI | OX I |
| ARLY | ACTION MEASURES | | | | | | | | |
| 4-2 | WOOD FURNITURE AND MISC WOOD COATINGS | \$4,900 | | | | \$7,100 | | | |
| A-6 | SUBSTITUTE COATINGS & SOLVENTS, AUTO REFINISHING | \$2,100 | | | | \$3,000 | | | |
| A-7 | SUBSTITUTE COATINGS FOR MARINE VESSELS | \$2,000 | | | | \$2,900 | | | |
| A-11 | SUB CLEAN-UP SOLVENTS FOR SURFACE COATING | \$1,100 | | | | \$1,600 | | | |
| A-12 | METAL SOLVENT CLEANING & DEGREASERS | \$10,000 | | | | \$14,500 | | | |
| A-15 | SEMICONDUCTOR MANUFACTURING | \$2,300 | | | | \$3,300 | | | |
| B-13 | VALVES, PUMPS & COMPRESSORS | \$15,000 | | | | \$21,800 | | | |
| B-15 | REFINERY BOILERS AND HEATERS | | \$6,600 | | | | \$9,600 | | |
| 8-0 | INDUSTRIAL BOILERS | | \$6,800 | | | | \$9,900 | | |
| 2-9 | GAS TURBINES | | \$15,500 | | | | \$22,500 | | |
| C-10 | UTILITY BOILERS | | \$25,700 | | | | \$37,300 | | |
| -7 | SOIL DECONTAMINATION | \$36,700 | | | | \$36,700 | | | |
| -1 | SHIP BERTHING | | \$25,300 | | | | \$36,700 | | |
| | | | | | | | | | |
| -9 | PAPER, FABRIC AND GLASS COATING | \$5,000 | | | | \$5,900 | | | |
| | PAPER, FABRIC AND GLASS COATING AEROSPACE ASSEMBLY COATINGS | \$5,000 Savings | | | | \$5,900 | | | |
| -4 | · | | | | | \$5,900 \$27,600 | | | |
| -4 -5 | AEROSPACE ASSEMBLY COATINGS | Savings | | | | | | | |
| -4 -5 -13 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING | Savings \$19,000 | | | | \$27,600 | | | |
| -4 -5 -13 -14 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING | Savings \$19,000 \$3,300 | | | | \$27,600 \$4,800 | | | |
| -4 -5 -13 -14 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM | \$19,000 \$3,300 \$2,100 | | | | \$27,600 \$4,800 \$3,000 | | | |
| -9 -4 -5 -13 -14 -16 -17 -18 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING | \$avings \$19,000 \$3,300 \$2,100 \$3,000 | | | | \$27,600 \$4,800 \$3,000 \$4,400 | | | |
| -4 -5 -13 -14 -16 -17 -18 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 | | | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 | | | |
| -4 -5 -13 -14 -16 -17 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 | | | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 | | | |
| -4 -5 -13 -14 -16 -17 -18 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS IMPROVED VAPOR RECOVERY INSTAL. & REPAIR | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 \$110 | | | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 \$150 | | | |
| -4 -5 -13 -14 -16 -17 -18 -2 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS IMPROVED VAPOR RECOVERY INSTAL. & REPAIR SUMPS, PITS, & WASTEWATER SEPARATORS | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 \$110 \$2,900 | | | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 \$150 \$4,200 | | | |
| -4 -5 -13 -14 -16 -17 -18 -2 -3 -4 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS IMPROVED VAPOR RECOVERY INSTAL. & REPAIR SUMPS, PITS, & WASTEWATER SEPARATORS BOAT GASOLINE REFUELING OPERATIONS | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 \$110 \$2,900 \$1,200 | \$4,000 | | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 \$150 \$4,200 \$1,700 | \$5,800 | | |
| -4 -5 -13 -14 -16 -17 -18 -2 -3 -4 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS IMPROVED VAPOR RECOVERY INSTAL. & REPAIR SUMPS, PITS, & WASTEWATER SEPARATORS BOAT GASOLINE REFUELING OPERATIONS CYCLIC STEAM PRODUCTION WELLS | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 \$110 \$2,900 \$1,200 | \$4,000 | \$30,000 | | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 \$150 \$4,200 \$1,700 | | \$43,500 | |
| -4 -5 -13 -14 -16 -17 -18 -2 -3 | AEROSPACE ASSEMBLY COATINGS AUTOMOBILE ASSEMBLY COATING DISC MANUFACTURING EXPANDED PLASTICS AND BLOWING FOAM PERC DRY CLEANING PETRO DRY CLEANING UNDERARM PRODUCTS IMPROVED VAPOR RECOVERY INSTAL. & REPAIR SUMPS, PITS, & WASTEWATER SEPARATORS BOAT GASOLINE REFUELING OPERATIONS CYCLIC STEAM PRODUCTION WELLS CRUDE OIL PIPELINE HEATERS | \$avings \$19,000 \$3,300 \$2,100 \$3,000 \$2,000 \$400 \$110 \$2,900 \$1,200 | \$4,000 | \$30,000 | \$ 12,000 | \$27,600 \$4,800 \$3,000 \$4,400 \$2,900 \$600 \$150 \$4,200 \$1,700 | | \$43,500 | \$17,40 |

| CONTROL MEASURE | | D | DCF C/E PER TON REDUCTION OF | | | LCF C/E PER TON REDUCTION OF | | | |
|-----------------|---|----------|------------------------------|----------|----------|------------------------------|-----------|----------|----------|
| NUMBER | DESCRIPTION | ROG | NOX | SOX | PM | ROG | NOX | SOX | PM |
| | | | | | | | | | |
| D 44 | | | | | | -7/ 000 | 407 500 | | |
| B-11 | **OCS EXPLORATION, DEVELOPMENT, PRODUCTION | \$24,800 | \$16,200 | | | \$36,000 | \$23,500 | | |
| B-14 | OILFIELD STEAM GENERATORS | | \$4,000 | | | | \$5,800 | | |
| C-1 | COMMERCIAL BAKERY FUGITIVE EMISSIONS | \$4,400 | | | | \$6,400 | | | |
| C-2 | BREWERY FUGITIVE EMISSIONS | \$20,000 | | | | \$29,000 | | | |
| C-3 | **COMMERCIAL CHARBROILING | \$25,000 | | | \$6,200 | \$36,300 | | | \$9,000 |
| C-7 | SMALL INDUSTRIAL BOILERS | | \$24,000 | | | | \$34,800 | | |
| C-4 | RUBBER PRODUCT MFG PROCESSES | \$5,600 | | | \$2,500 | \$8,100 | | | \$3,600 |
| C-5 | UNCONFINED ABRASIVE BLASTING | | | | \$37,800 | | | | \$46,500 |
| C-6 | WOODWORKING DUST CONTROL SYSTEM | | | | \$12,000 | | | | \$17,400 |
| C-11 | NOX-OUT TECHNOLOGY ON AFTERBURNERS | \$62,200 | | | | \$76,300 | | | |
| C-12 | **STAT. NON-GENER I/C ENG. & TURBINES | \$48,200 | \$14,000 | | | \$69,900 | \$20,300 | | |
| D-2 | DOMESTIC SOLAR WATER HEATER RETROFIT | | \$530,000 | | | | \$768,500 | | |
| D-3 | HEAT TRANSFER MODULES ON NEW GAS CENTRAL FURN | ACES | \$41,500 | | | | \$60,200 | | |
| D-4 | FLUE GAS DAMPERS ON NEW HOME WATER HEATERS | Savings | | | | | | | |
| D-7 | **, ***UTILITY EQUIPMENT | \$1,000 | | | | \$1,900 | | | |
| E-1 | PESTICIDE FORMULATION AND USE | \$1,300 | | | | \$2,600 | | , | |
| E-2 | LIVESTOCK WASTES | \$1,800 | | | | \$2,200 | | | |
| F-1 | INSTALLATION OF BARCT | \$17,500 | \$24,500 | \$18,300 | \$5,300 | \$25,400 | \$35,500 | \$26,500 | \$7,700 |
| F-2 | SULFUR CONTENT OF GASEOUS FUELS | | | \$20,000 | | | | \$29,000 | |
| F-3 | SULFUR CONTENT OF LIQUID FUELS | | | \$25,000 | | | | \$36,300 | |
| F-4 | CONSTRUCTION OF ROADS AND BUILDINGS | | | | \$9,300 | | | | \$13,500 |

| | CONTROL MEASURE | DCF C/E PER TON REDUCTION OF | | | LCF C/E PER TON REDUCTION OF | | | |
|--------|--|------------------------------|---------|----|------------------------------|---------|----|--|
| NUMBER | DESCRIPTION | ROG | NOX SOX | PM | ROG | NOX SOX | PM | |
| G-3 | RADIAL TIRES TO REPLACE BIAS-PLY TIRES | Savings | | | | | | |
| H-2.2 | RIDE-SHARING | Savings | | | | | | |
| 1-2 | NEW JET AIRCRAFT | \$800 | | | \$800 | | | |
| 1-3 | MARINE VESSEL TANKS-HSKPG | \$1,800 | | | \$1,800 | | | |
| 1-4 | MARINE DIESEL OPERATIONS | \$5 | 5,400 | | | \$7,800 | | |
| I-5 | MARINE FUEL OILS | | \$3,000 | | | \$3,000 | | |
| I-6 | NEW PLEASURE BOATS-2STK | \$4,400 | | | \$6,400 | | | |
| | NEW PLEASURE BOATS-4STK | \$37,100 | | | \$53,800 | | | |

Footnotes:

- a. Measures, whose cost effectiveness values were not estimated, are not included in the table.
- b. Figures presented are average C/E values.
- ** Within these source Categories, the recommended control technique reduces several pollutants simultaneously; (e.g., in OCS development, electrification reduces NOX and ROG together.) Within such categories, the C/E analyses ignored pollutants with reductions of less than 1 ton/day.)
- *** In this category, the C/E analyses combined ROG reductions and CO reductions at a 1 :: 10 ratio.

Chapter 6. Unless otherwise noted, the implementing agency is the District.

References References directly cited or used to provide general background information are listed in this section.

DESCRIPTION OF CONTROL MEASURES

The following sections describe individual control measures by source category:







STATIONARY SOURCES

This section contains stationary sources contributing to the emissions in the Basin. Tables I-2A through I-2F represent proposed control measures aimed at reducing emissions from these sources, followed by detailed description of control measures.



A- SURFACE COATING AND SOLVENT USE

Surface coatings and solvent use contribute the major portion of stationary source ROG emissions in the Basin. The control measures proposed for reducing emissions from these sources are listed in Table I-2A. The concepts of control measures for each of the source categories are described in detail in the following section.

TABLE I-2A TIER I CONTROL MEASURESSURFACE COATING AND SOLVENT USE

| AQMP CONT | TITLE |
|-----------|---|
| A-1 | Further Emission Reductions from Wood Flatstock Coating, [ROG] |
| A-2* | Further Emission Reductions from Manufactured Wood Furniture and Miscellaneous Wood Products Coating, [ROG] |
| A-3 | Further Emission Reductions from Can and Coil Coating, [ROG] |
| A-4 | Further Emission Reductions from Aerospace Assembly and Component Coating, [ROG] |
| A-5 | Further Emission Reductions from Automobile Assembly Coating, [ROG] |
| A-6* | Substitute Solvents Used in Automobile Refinishing, [ROG] |
| A-7* | Substitute Solvents Used for Marine Vessels Coating, [ROG] |
| A-8 | Control of Emissions from Architectural Coatings, [ROG] |
| A-9 | Further Emission Reductions from Paper, Fabric, and Film Coating, [ROG] |
| A-10 | Further Emission Reductions from Graphic Art Operation, [ROG] |
| A-11* | Substitute Solvents Used for Clean-up of Surface Coating, [ROG] |
| A-12* | Further Emission Reductions from Metal Cleaning and Degreasing, [ROG] |
| A-13 | Control of Emissions from Rigid and Flexible Disc Manufacturing Operation, [ROG] |
| A-14 | Control of Emissions from Expanding Plastics and Blowing Foam Manufacturing Operation, [ROG] |
| A-15* | Control of Emissions from Semiconductor Manufacturing |
| A-16 | Operation, [ROG] Further Emission Reductions from Perchloroethylene Dry Cleaning Operation, [ROG] |
| A-17 | Further Emission Reductions from Petroleum Dry Cleaning Operation, [ROG] |

TABLE I-2A TIER I CONTROL MEASURESSURFACE COATING AND SOLVENT USE (continued)

| • | CONTROL No. | TITLE |
|------|----------------|--|
| A-18 | | Control of Emissions from Underarm Products, [ROG] |
| A-19 | | Control of Emissions from Domestic Products, [ROG] |
| A-20 | | Control of Emissions from Solvent Waste, [ROG] |
| A-21 | | Further Emission Reductions from Adhesives, [ROG] |

FURTHER EMISSION REDUCTIONS FROM WOOD FLATSTOCK COATING [ROG]

<u>SUMMARY</u>

Source Category: Wood Flat Stock Coating Operations

Control Methods: Eliminate Small Source Exemption; Record keeping; Low-Solvent Coatings; Alternative Coating Methods

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 0.9 | 0.9 0.4 | 0.9 |

Control Cost: Not Determined

Other Impacts: Greater Use of Some Potentially Toxic Materials Due

to Possible Toxicity of UV Curable Coatings

DESCRIPTION OF SOURCE CATEGORY

Background

Wood flat stock is wood panels not used for furniture. This paneling is used in mobile homes and wall decorations. The paneling is usually coated with fillers, sealers, stains, inks, and clear topcoats. Lamination is involved when the wood panel is bonded with adhesive to paper or single sheets.

In this operation, volatile organic compound (VOC) emissions occur primarily at the coating lines. Oven exhausts are discrete point sources and coaters and rollers are sources of fugitive emissions.

Regulatory History

Wood flat stock coating operations are currently regulated under Rule 1104. This rule establishes one VOC limit, 250 grams per liter, for all types of wood flat stock coatings. Additionally, the Rule regulates VOC contents for inks and adhesives.

PROPOSED METHOD OF CONTROL

One means of reducing emissions is by eliminating the small source exemption in the Rule. A small source exemption for users of less than three gallons per day has been in effect in the rule to provide the few job shop wood panel manufacturers more compliance time. The proposed control method also requires daily compliance and record keeping for all sources.

Another means of achieving emissions reduction is by lowering the VOC limit for coating used on printed interior wall panels. This limit, 200 grams per liter (less water), was first recommended by EPA in the Control Techniques Guideline for this source.

Finally, conventional coating systems can be replaced with ultraviolet coating systems to reduce emissions. Ultraviolet curing relies on the rapid uptake of high intensity energy from an external source to polymerize the low weight components of special radiation curable coatings. Of all the types of radiation curing ultraviolet curing is the more widely used technique because of its relatively low equipment cost and ease of maintenance. Ultraviolet curing has been found to be especially useful on particle board coating lines. Two wood flat stock coating facilities currently utilize Ultra Violet (UV) curable coatings in the Basin.

EMISSIONS REDUCTION

Wood flat stock coating operations resulted in approximately 0.9 tons per day of ROG in 1985. Emission estimates for 2000 and 2010 are 0.9 and 0.9 tons per day, respectively.

Implementation of this control measure will result in an overall emission reduction of 13 to 65 percent. Thus, this measure could achieve an ROG reduction of 0.4 tons per day in 2000 and 0.4 tons per day in 2010.

COST EFFECTIVENESS

To be determined later.

OTHER IMPACTS

Potential toxicity of photoinitiators in some radiation curable coatings.

FURTHER EMISSION REDUCTIONS FROM MANUFACTURED WOOD FURNITURE AND MISCELLANEOUS WOOD PRODUCTS COATING [ROG]

SUMMARY

Source Category: Wood Furniture Manufacturing

Control Methods: Add-On Controls; Alternative Coatings; More

Efficient Application Equipment

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 21.2 | 30.5 | 31.9 |
| ROG Reduction | | 24.4 | 25.5 |

Control Cost: \$4,900 Per Ton of ROG

Other Impacts: Movement of Sources to Out-of-Basin Areas;

Greater Use of Some Potentially Toxic Materials.

DESCRIPTION OF SOURCE CATEGORY

Background

Wood products, such as tables, chairs, bookcases and utensils, are made by forming, assembling, and coating the components. Components are coated to improve product appearance and durability. The stains, topcoats, sealers, fillers, primers, toners, and washcoats used on these products emit ROG emissions which contribute to ozone formation. This measure is directed at reducing ROG emissions from coatings applied during the manufacture of wood furniture and miscellaneous wood products.

Most wood items are stained to give a natural wood-like finish and topcoated with a transparent coating to protect the stained surfaces. A relatively small number of items are painted with a pigmented coating that hides the wood grain. Wood-grain-appearing laminate tops are also used in lieu of conventional coatings on some products.

Dipping, hand wiping, and spraying are the techniques commonly used to apply coatings to wood products. Stain is usually applied by spraying and hand wiped to accent the wood grain. Most topcoats are also applied by spray equipment. Spray application results in lower transfer efficiency than dipping, but advances in spray application technology are occurring which will reduce the disparity.

Regulatory History

Rule 1136, Wood Furniture and Cabinet Coatings, was adopted September 16, 1983 to reduce VOC emissions from coating of wood furniture and cabinets. The rule is primarily designed to regulate wood staining and clear overcoating. The rule requires the use of airless or air-assisted airless spray equipment. Equivalent methods of emission reductions are also allowed. In addition, companies using more than 10,000 gallons of coatings per year were require to enter into a demonstration program directed at further reducing VOC emissions from wood coating operations. Rule 1136 is not applicable to miscellaneous wood products.

In the 1982 AQMP Revision, Control Measure B5 was proposed to reduce ROG emissions from wood furniture finishes. That tactic suggested the use of electrostatic-spray equipment and waterborne coatings to reduce ROG emissions. Subsequent analysis showed that the use of electrostatic-spray equipment was not appropriate in most cases since wood is not a good conductor of electricity. It was also concluded that the use of sensitizers to make the wood conductive would probably result in a net increase in ROG emissions. Waterborne finishes also did not prove acceptable since the water caused the grain to rise.

PROPOSED METHOD OF CONTROL

Emissions from wood furniture and miscellaneous wood product coating operations can be reduced through: (1) the use of add-on control devices; (2) requiring the use of higher transfer efficiency application techniques; (3) reformulation of wood coatings and solvents; or (4) setting cleanup requirements. Proposed regulatory requirements to minimize emissions from wood coating operations are as follows.

Add-On Control Devices

Require carbon adsorption, afterburner, or equivalent control device for all sources. This will result in about a 80 percent reduction in ROG emissions. These devices are already used in similar applications.

Application Equipment

Establish a 65 percent transfer efficiency requirement. Two spray guns, Speedflo Challenger 601 series using thin film atomization and Wagner model G100 AC using high fluid pressure and low air pressure, meet the 65 percent transfer efficiency criteria. Flow coating, dip coating and roller coating

are being used in some wood coating applications and achieve about 95 percent transfer efficiency. On the average, this requirement will result in a 9 percent control efficiency.

Reformulation

Require low ROG coatings and solvents until the 90 percent control level is achieved. The ROG content of many coatings used on wood products can be reduced by reformulating with higher solids content or substituting water or exempt solvent for ROG components. The extent to which the ROG content can be reduced for some types of wood coatings is probably less than for comparable coatings for other substrates (e.g. metal or plastic).

Coatings which could be reformulated to lower the ROG content include:

- o Waterborne -- fillers and topcoats applied over sealer;
- Exempt solvent -- fillers, pigmented coatings, sealers, semitransparent stains, and topcoats; and
- o High solids -- fillers and pigmented coatings.

Pure cleanup solvents can also be reformulated by substituting water and/or exempt solvent. A variety of low ROG cleanup solvents are currently available and used at aerospace facilities and metal paint shops. Many of these comply with a 200 gram per liter limit.

Cleanup Requirements

Require improved procedures for equipment cleaning and disposal of solvent-laden cloth and paper. Spray equipment can be either cleaned to a closed system which captures the cleaning solvent or disassembled and cleaned in a vat with a lid. Solvent-laden cloth (e.g. rags) and paper can be stored and disposed of in closed containers to minimize ROG emissions. These procedures are already being used in a variety of facilities due to other District rules. These requirements along with requiring 200 gram per liter cleanup materials will result in a 77 percent decrease in related emissions

EMISSIONS REDUCTION

Wood coating operations resulted in approximately 21.2 tons per day of ROG in 1985. Emission estimates for 2000 and 2010 are 30.5 and 31.9 tons per day, respectively.

Implementation of this control measure will result in an overall emission reduction of about 80 percent. Thus, this measure could achieve an ROG reduction of 24.4 tons per day in 2000 and 25.5 tons per day in 2010.

COST EFFECTIVENESS

The mean cost-effectiveness of meeting the requirements proposed above will be about \$4,900 per ton of ROG reduced. The overall range of cost-effectiveness is about \$4,000 to \$15,900.

Switching to 65 transfer efficiency methods will generally result in a cost saving, since material usage will be reduced. This savings will offset some of the cost associated with add-on control devices or more expensive reformulated paints.

OTHER IMPACTS

The proposed actions will likely result in some wood coating operations moving out of the Basin to avoid control costs. In addition, the use of add-on control devices may result in some solid or liquid wastes which will have to be disposed of properly. Finally, reformulation may result in the use of some chlorinated solvents which are under study because of their potential toxic effects. District staff is monitoring these studies and will propose necessary actions, if any, to curb such effects.

FURTHER EMISSION REDUCTIONS FROM CAN AND COIL COATING [ROG]

SUMMARY

Source Category: Can and Coil Coating

Control Methods: Reduced Solvent-Content in Coatings

O/M Plans; Record-Keeping

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 8.4 | 9.5 | 9.8 |
| ROG Reduction | | 0.5 | 0.5 |

Control Cost: Minor Administrative Cost

Other Impacts: Administrative Impact on District

Uther impacts: Administrative impact on pistret

DESCRIPTION OF SOURCE CATEGORY

Background

Coil coating is the coating of any flat metal sheet or strip that comes in rolls or coils. The metal is typically roll coated on one or both sides on a continuous production line basis. Coatings are applied as primers, protective finishes and decorative coatings. Following the application of coatings, the roll or coil is drawn, formed, or shaped into finished products to be used for cans, appliances, roof decks, shelving, industrial and commercial siding, automobiles, gutters, and many other items. There are eight coil manufacturing and coating facilities located in the Basin.

In the manufacture of metal containers, cylinders, pails, and drums, coatings are applied to the inside and outside surfaces to prevent corrosion, to provide a protective and decorative finish, and to serve as liners and sealers. Generally, coatings applied to inside surfaces are spray coated, whereas exterior coatings are roller coated. There are 21 facilities engaged in can manufacturing and coating in the Basin.

In both can and coil operations, ROG emissions occur in the coating area, the preheat and baking zones of the oven and the quench area. The majority of emissions occur after the coating area, and before the coated coil and cans enter the oven.

Regulatory History

Emissions for can and coil operations are currently regulated under Rule 1125. This rule stems from a Control Techniques Guideline promulgated by EPA and establishes VOC limits for the various types of coatings used in these operations. District Rule 1125 also contains a provision which allows the use of non-complying coatings if comparable emissions reductions are achieved through the use of an approved control device, such as an incinerator or a carbon adsorption system.

PROPOSED METHOD OF CONTROL

This tactic proposes to further recuce emissions from can and coil coating operations by lowering the allowable VOC limit for some of the coatings, requiring operating and maintenance plans for control equipment, and requiring that records of solvent and coating use be maintained.

One means of achieving further emission reductions is by establishing a separate category for the coating of new and reconditioned drums, pails, and lids. The recommended RACT VOC limits for interior and exterior coatings for drums, pails, and lids are 510 gm VOC/liter and 420 gm VOC/liter, respectively.

To ensure that emission control equipment is properly operated and maintained, it is proposed that facilities be required to submit operation and maintenance plans. The intent of such a plan is to maintain high control efficiency in the control device and to minimize the device's deterioration. The Bay Area Air Quality Management District (BAAQMD) has adopted such a provision in its can and coil coating rule. The BAAQMD rule requires specification of the following elements in the plan: afterburner temperatures; burner maintenance schedule; and catalyst cleaning/recharging schedule and dust inspection schedule.

Finally, it is also proposed that sources submit records of coatings and solvent use to facilitate compliance and evaluation. This requirement already exists for those sources which choose to comply with Rule 1125 through the use of emissions control devices or other alternative emissions control methods.

EMISSIONS REDUCTION

It is estimated that can and coil operations accounted for approximately 8.4 tons per day of ROG emissions in 1985. In the years 2000 and 2010, ROG

emissions from this source category are expected to be about 9.5 tons per day and 9.8 tons per day, respectively.

The ROG emissions reduction associated with this measure is estimated to be about 5 percent. Thus, the reduction potential for the years 2000 and 2010 are 0.5 tons per day and 0.5 tons per day, respectively.

COST EFFECTIVENESS

Most of the proposed requirements are procedural in nature and are expected to result in only minor costs for additional staff time at affected plants. The VOC requirement is not expected to result in any additional cost since complying coatings are available and currently used by most facilities.

OTHER IMPACTS

District review of operation and maintenance plans and solvent use records would add to the workload of the District's Engineering and Enforcement Divisions.

FURTHER EMISSION REDUCTIONS FROM AEROSPACE ASSEMBLY AND COMPONENT COATING [ROG]

Summary

Source Category: Aerospace Assembly and Component Coating

Control Method: Higher Transfer Efficiency

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 7.3 | 5.5 | 5.7 |
| ROG Reduction | | 1.6 | 1.7 |

Control Cost: Savings

Other Impacts: Materials Savings; Reduced Downtime for Clean-up;

Reduction in Clean-up Solvent Use and Disposal of

Liquid Hazardous Waste

DESCRIPTION OF SOURCE CATEGORY

Background

The aerospace coating category encompasses the initial and rework coating of aircraft, helicopters, missiles and their related components. The coatings are applied for protection from environmental elements, drag resistance and appearance. Rework involves the removal of an existing exterior coating and the application of a new surface coat to assure that protection and performance characteristics are maintained. Interior component coatings are normally applied during the manufacturing process and remain for the life of the product. The coating process involves several steps, including surface preparation, base and topcoat application, and clean-up. Evaporative solvent emissions occur from the application and drying of the coating, the use of reduction and clean-up solvents for the spray equipment, and from unused paint stored at the facility

Regulatory History

ROG emissions from aerospace assembly and component coating operations are currently regulated under District Rule 1124. This rule establishes newly revised VOC limits of 350 grams per liter for primers, 600 grams per liter for topcoats, and 350 grams per liter for phosphate ester resistant primers as well as other coatings applied in the assembly process. The rule also requires the use of surface preparation or clean-up solvents with a composite vapor pressure greater than 45 millimeters of mercury at a temperature of 20 degrees Celsius, and allows for alternative emission reduction methods under equivalency provision.

PROPOSED METHOD OF CONTROL

Transfer efficiency

The proposed control measure herein is to incorporate a minimum transfer efficiency requirement into the existing rule. The requirement of a minimum 65 percent in-process transfer efficiency is being considered. Transfer efficiency is defined as the ratio of the weight or volume of coating solids adhering to an object to the total weight or volume respectively, of coating solids used in the process, expressed as a percentage.

The majority of coating applications in the aerospace industry are by conventional air atomized spraying. Transfer efficiency for this application method is in the range of 30 to 60 percent(DOHS, 1986). The use of electrostatic procedures in conjunction with conventional air atomized spraying can achieve a transfer efficiency as high as 65 to 85 percent (DOHS, 1986). This method is currently more applicable for initial coatings, as rework application using electrostatics has shown problems related to possible damage to on-board electronic components and the fear of ignition of fumes in the aircraft fuel tanks. In these cases, automated airless or air assisted airless spraying may be able to meet the minimum transfer efficiency. The possibility for further increased transfer efficiency of new aircraft or components also exists with the use of airassisted airless spraying in conjunction with electrostatics.

Reformulation

Aerospace coating formulators are attempting to develop products with a volatile organic compound(VOC) content below the currently regulated topcoat requirement limit of 600 grams per liter. A topcoat in the 420 grams per liter range may be possible within the next six to seven years. However, the products, if successfully developed, must first undergo extensive testing to meet military specifications which can take up to an additional three years to complete. Consequently, further reformulation literally becomes a long range control measure.

EMISSIONS REDUCTION

It is estimated that aerospace assembly and component coating operation accounted for approximately 7.3 tons per day of ROG emissions in 1985. Projections for the years 2000 and 2010 show ROG emissions of 5.5 tons per day and 5.7 tons per day, respectively.

The proposed transfer efficiency requirement would reduce ROG emissions in the South Coast Air Basin by about 30 percent or 1.6 tons per day in the year 2000 and 1.7 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed control requirements may result in modification of existing, or the purchase of new spray equipment with the rated transfer efficiency. Conventional air spraying systems will require replacement with more efficient airless air assisted spray guns or the use of an electrostatic system or ideally, a combination of both. The substantial savings realized in extended coating material use, and less down time for clean-up will outweigh the additional equipment costs.

OTHER IMPACTS

The proposed requirements will result in the generation of a smaller quantity of liquid hazardous waste due to less clean-up with solvents being required.

REFERENCES

Bernard, Dan. 1988. Deft, Inc.. Personal Communication with David Vensel, February, 1988.

Department of Health Services, State of California. 1986. Guide to Solvent Waste Reduction Alternatives. Alternative Technology and Policy Development Section, Toxic Substances Control Division. 1986.

Eaki, Mokhtar. 1988. Chemray Coatings Corp.. Personal Communication with David Vensel, February, 1988.

Kalfian, Charles. 1988. Randolph Products Co.. Personal Communication with David Vensel, February, 1988.

FURTHER EMISSION REDUCTIONS FROM AUTOMOBILE ASSEMBLY COATING [ROG]

SUMMARY

Source Category: Automobile Assembly Coating Operations

Control Methods: Higher Transfer Efficiency; Exhaust Controls;

Alternative Solvents; Shifting Time of Emission

Discharge.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 5.9 | 5.9 | 6.1 |
| ROG Reduction | | 1.2 | 1.2 |

Cost Control: Add on Control- \$19,000 Per Ton of ROG;

Transfer Efficiency- Savings

Other Impacts: Increased Air Toxic Emissions from Exempt Solvents;

Increased Liquid/Solid Waste and NO, Emissions from

Add-on Control Devices

DESCRIPTION OF SOURCE CATEGORY

Background

At present, there are two motor vehicle assembly operations in the Basin: a GM plant in Van Nuys which manufactures and coats light-duty passenger vehicles and a Toyota Plant in Long Beach which manufactures and coats light-duty truck beds.

In both operations the assembly and coating of the vehicle is a multistep process conducted on an assembly-line conveyor system. Prior to the application of any coatings, the metal body unit is cleaned to prevent corrosion and improve paint adhesion. This is most often accomplished by immersion in a zinc phosphate solution. After drying in an oven, the unit is immersed in an electrophoretic primer coating, and then sent through another drying oven. Next, a primer coating to provide a smooth surface is applied and oven dried. Finally, top coats to provide the final color and

protective finish are applied and baked in drying ovens. Both one- and two-tone metallic and nonmetallic top coats are applied at the GM plant, while the Toyota plant applies mainly one-tone nonmetallic top coats.

Regulatory History

Presently, ROG emissions from automobile assembly operations are regulated under Rule 1115. This rule establishes ROG limits for each of the coatings applied in the process and allows a plant's operation to meet these limits under equivalency provisions.

Measure B4 of the 1982 AQMP Revision proposed the use of high-solids coatings (70 percent by volume) to further reduce ROG emissions. District staff, however, currently believes that these coatings are not available at this time and will not be available in the near term. This measure proposes some alternative methods to further reduce emissions from automobile assembly operations.

PROPOSED METHOD OF CONTROL

ROG emissions can be reduced by increased use of high-transfer-efficiency equipment, the installation of exhaust controls, use of low-ROG coatings, use of low-vapor-pressure cleanup solvents, or shifting the time of day emissions are released.

The majority (approximately 90 percent) of nonmetallic top coats are applied with electrostatic spray equipment with transfer efficiencies in excess of 75 percent. A much smaller percentage (approximately 30 to 35 percent) of the metallic coatings are applied with electrostatic spray equipment. Many of these spray operations may be amenable to electrostatic and/or turbo spray in order to further reduce ROG emissions.

Another means of achieving emissions reductions from these plants would be to require the installation of exhaust controls such as carbon adsorbers or incinerators. Currently at the GM plant, several stack vents for the electrophoretic and other coating processes are vented to incinerators to mitigate odors. These incinerators also reduce exhaust ROG emissions. Several other stacks, which are vented directly to the atmosphere without controls, could add exhaust controls to further reduce ROG emissions.

ROG emissions can be further reduced through the use of lower-ROG formulations in each of the coating processes. At GM, reformulation efforts are currently being concentrated on nonmetallic color coatings that are available for the newly installed electrostatic spray equipment. For metallic coatings, exempt-solvent formulations are being developed and may be available in the near term.

Low-vapor-pressure cleanup solvents, currently being used in other industries, may be substituted to reduce ROG emissions in the cleanup of

vehicles, spray booths and application equipment. This control approach is further addressed in the Control Measure #88-A-11 on clean-up solvents.

Finally, an alternative means of reducing the potential for ozone formation may be to shift the time of day the emissions occur. Assembly and/or coating operations could be shifted to non-daylight hours in order for ROG emissions to avoid undergoing photochemical reactions.

EMISSIONS REDUCTION

These plants contributed approximately 5.9 tons of ROG per day in 1985. In the years 2000 and 2010 it is estimated that emissions will be about 5.9 and 6.1 tons per day, respectively. Potential emissions reduction from this measure is estimated to range from 10 to 30 percent. Therefore, implementation of this measure would result in reductions of about 1.2 tons per day in the year 2000, and about 1.2 tons per day in the years 2000 and 2010.

COST EFFECTIVENESS

Several control options are proposed within this measure. Given the material savings involved, requiring improved transfer efficiency results in cost savings. The costs of using low VOC coatings have to be calculated on a case-by-case basis.

For add-on controls, the control cost is estimated to be \$19,000 per ton of ROG. This assumes an 80 percent control efficiency.

OTHER IMPACTS

There is a potential increase in air toxic emissions due to application of exempt solvents. Additional liquid or solid waste will be expected, if carbon adsorbers are used. Lastly, if incinerators are fixed with supplemental natural gas, there will be some increase in gas consumption and consequently, $NO_{\mathbf{x}}$ emissions.

REFERENCES

South Coast Air Quality Management District, Enforcement Division. 1986. Personal communication with A. Latif, November 1986..

SUBSTITUTE COATINGS/SOLVENTS USED IN AUTOMOBILE REFINISHING [ROG]

<u>SUMMARY</u>

Source Category: Automobile Refinishing

Control Methods: Alternative Solvents & Coating; Improved Transfer

Efficiency; Improved Cleanup Equipment; and Add-On

Controls

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 16.5 | 25.4 | 29.8 |
| ROG Reduction | | 24.1 | 28.3 |

Control Cost: \$2,100 to 6,000 Per Ton of ROG

Other Impacts: Decreased Hazardous Liquid Wastes, Increased Use of

Chlorinated Solvents

DESCRIPTION OF SOURCE CATEGORY

Background

Automobile refinishing is performed by high volume commercial chain production shops such as Earl Scheibs, common neighborhood auto body repair/repaint shops, new car dealers, small repair garages, and by "do-it-yourselfers". The three main classes of paint used to refinish vehicles are primers, enamels and lacquers. These coatings are low solid, high solvent coatings which are air dried and applied with brush and/or spray equipment. Primers are applied to achieve a consistent base coat color below the topcoat and to ensure compatibility of the topcoat and surface. Acrylic enamel and lacquer topcoats are applied to provide both the color and protective finish. Evaporative solvent emissions occur from the application of the paint, the use of reduction and clean-up solvents for the spray equipment and from unused paint stored at the facility.

Recently, a new type of new automotive topcoat called base coat/clear coat has been introduced by foreign manufacturers. This color/cleartechnology

consists of a thin fast drying layer of pigmented coating, normally a lacquer, followed by a thicker layer of a clear protective finish, normally an enamel. Currently, approximately 50 percent of all new automobiles sold in the Basin are coated with this finish. By 1992, nearly all automobiles are expected to be painted with this new type of technology.

According to paint manufacturers, color/clear technology is much more difficult to match than conventional single coat technology. The refinisher must repaint automobiles with this type of finish with a similar two coat technology without the more sophisticated application and control technology used for OEM finishes. Color/clear technology also requires more frequent cleaning of application equipment. Therefore, clean-up emissions are greater with this type of coating system and can be expected to increase in the future.

A survey of paint manufacturers indicates that only limited research and development has been directed toward developing low solvent or waterborne topcoat formulations. Actions are proposed in this control measure to facilitate the research and development of lower VOC coatings and clean-up formulations.

Regulatory History

ROG emissions from automobile refinishing operations are largely uncontrolled. At present, the District does not have a source specific rule directed at automobile refinishing operations. District Rule 1107, which establishes requirements for coating metal parts and products, currently exempts automobile rework facilities from any requirements other than record-keeping of coating and solvent usage. The emissions from these operations are currently only limited under District Rule 442 which is directed at general solvent usage. This Rule's limiting values are directed toward large volume operations. Few automotive refinishers encounter problems staying under these limits (CARB, 1982). The proposed control measure will be applicable to all motor vehicle coating operations, other than original equipment manufacturer (OEM) assembly lines.

For the 1982 AQMP Revision, control measure B8 was proposed specifically directed to reduce VOC emissions from automobile refinishing operations (SCAQMD, 1983). Measure B8 proposed the substitution of low solvent coatings for the high solvent coatings currently in use. In early 1983, District Rules Development staff evaluated measure B8 for purposes of developing a rule (CARB, 1982). They concluded that lower VOC emitting coatings (i.e. waterbased and higher solid) were not available and that exhaust control technology was too costly for auto refinishing operations. Based on its evaluation, Rules staff recommended and the Board approved that this measure be deferred to the Further Study Category and that the statewide Technical Review Group continue to evaluate this measure as complying coatings are developed by manufacturers.

PROPOSED METHOD OF CONTROL

Emissions from automobile refinishing can be reduced through: (1) reformulation of primers, topcoats, and cleaning solvents; (2) the use of improved transfer efficiency spray equipment; (3) specification of requirements for cleanup;, and (4) possibly the use of add-on control devices for high volume shops.

Reformulation

Primers

Establish VOC limit of 250 g/l (2.1 lbs/gal) as applied. This is to require substitution of low solvent/waterborne primers for conventional formulations currently in use. A survey of current products indicates that high solids primers (such as marketed by Morton Paint Co., trade name - Eliminator) and waterborne formulations (such as marketed by RM/BASF, trade name - NOVAPRIME HP 100) are available. Although these products are only used on limited scale, they are indicative of the type of products that can be used to meet the proposed requirement.

Top-Coats

Establish current VOC limit of 588 to 624 g/l as applied for enamels and 744 g/l as applied for lacquers . This is to establish a cap on VOC content based on existing low VOC formulations.

Establish future effective VOC limit of 420 g/l as applied for topcoats. These limits would be technology forcing to facilitate the development of lower VOC formulations. These limits are accepted industry standards for metal parts coatings and are in place in Rule 1107. Since these limits were first established in 1979 for metal parts, complying coatings have been developed and are now in widespread use.

Clean-up Solvents

Establish VOC limit of 200 g/l for surface preparation solvents used in automotive rework/refinish facilities. This is to require substitution of low VOC cleanup solutions in place of conventional formulations (840g/l VOC). This limit is currently specified for the cleanup of metal parts coatings in District Rule 1107. District staff believe that such low VOC cleanup solutions can also be used in automotive rework/refinish facilities.

Improved Transfer Efficiency

Establish a 65 percent transfer efficiency requirement. Several spray guns currently marketed meet the 65 percent transfer efficiency criterion. This criterion is the same as that currently in place for miscellaneous metal parts coating.

Cleanup Requirements

Require improved procedures for equipment cleaning and disposal of solvent-laden cloth and paper. Spray equipment can be either cleaned to a closed system which captures the cleaning solvent or disassembled and cleaned in a vat with a lid. Solvent-laden cloth (e.g. rags) and paper can be stored and disposed of in closed containers to minimize ROG emissions. These procedures are already being used in a variety of facilities due to other District rules.

Add-On Control Devices

The use of add-on controls is not required by this measure, but it provides an equivalency provision. Carbon absorption, afterburner, or equivalent control device for high volume shops can be used in lieu of reformulation of primers and topcoats, if equivalent emission reductions can be achieved. The aforementioned devices can be designed to have 90 to 98 percent control efficiency.

EMISSIONS REDUCTION

ROG emissions from auto refinishing operations were about 16.5 tons per day in 1985. In the years 2000 and 2010 emissions from this sector are expected to increase to 25.4 tons per day and 29.8 tons per day, respectively. Implementation of the proposed requirements, minus add-on controls, will reduce ROG emissions from auto refinish by about 95 percent or 24.1 and 28.3 tons per day in the years 2000 and 2010, respectively. Requiring add-on controls for high volume shops would probably provide an additional ROG reduction of about 1 ton per day.

COST EFFECTIVENESS

The use of compliant coatings will raise the material costs for most auto refinshers. The cost-effectiveness are estimated to be \$2,100 for compliant primers; \$6,000 for compliant enamels, and \$3,000 for compliant lacquers.

OTHER IMPACTS

The proposed actions will result in a potential increase in solid and liquid hazardous wastes from the auto paint shops due to the use of chlorinated solvents or add-on controls. There will also likely be, increased emissions of chlorinated solvents which are under study because of their potential toxicity.

REFERENCES

California Air Resources Board. 1982. <u>A Discussion of Alternatives To Reduce Emissions of Volatile Organic Compounds From the Automotive Refinishing Industry.</u>

South Coast Air Quality Management District. 1988. "Proposed Rule 1151 Non-Assembly Line Motor Vehicle Coating Operations," Internal Staff Report. February 1988.

SUBSTITUTE SOLVENTS USED FOR MARINE VESSELS COATING [ROG]

SUMMARY

Source Category: Marine Vessel Coating

Control Methods: Reduced Solvents in Coatings

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 4.4 | 4.5 | 4.7 |
| ROG Reduction | | 1.8 | 1.9 |

Control Cost: \$2,000 Per Ton of ROG

Other Impacts: Possible Movement of Shipbuilding Operations

DESCRIPTION OF SOURCE CATEGORY

Background

Marine coatings are applied to boats, ships, and their appurtenances to protect the surfaces and to enhance appearance. The coatings are applied by brush, spray, or roller and are air dried. Because of the large surfaces involved it is not practical to attempt to capture the emissions resulting from solvent evaporation or to try to duct them to a control device. This tactic applies to both new construction and the refinishing and repair of existing vessels.

In the South Coast Air Basin, there are four shipyards where coatings are used in the construction and repair of marine vessels. These shipyards include Todd shipyards and Bethlehem Steel Corporation located in San Pedro and California located in Long Beach. Todd and Long Beach Naval Shipyards perform construction work for the U.S. Navy. The other two shipyards deal mostly with the repair and refurbishing. Application of the coatings to ships in these shipyards and the associated use of solvent for thinning and cleanup generate emissions of volatile organic compounds that act as precursors to photochemical oxidants.

The proposed strategy by which emissions will be reduced is the substitution of marine coatings containing less solvent than coatings now being used. This will be accomplished and made enforceable by assigning numerical VOC limits for the various kinds of coatings used.

Regulatory History

This tactic was identified as Measure B3 in the 1982 AQMP revision. Since it has not been adopted, but remains available for hydrocarbon emission reduction, it is reintroduced herein.

The measure was prepared in rule format as proposed Rule 1106. A public workshop was held in 1985, and the U.S. Navy began work to require lower solvent technology to be provided by their suppliers and reflected in their military specifications. Staff was advised of the Navy's ability to meet a 340 gram per liter criterion, and proposed Rule 1106 was revised to require the incorporation of the new capability. An internal workshop was held in May, 1987.

After the internal workshop of May, 1987, the proposed rule was ready to be set for public workshop and for presentation to the District Board for adoption in August or September, 1987. Due to a reevaluation of priorities, however, the measure is currently scheduled for Board action in November 1988.

PROPOSED METHOD OF CONTROL

Since it is not practical to attempt to collect the fumes generated in painting very large vessels, compliance with the emission reduction objectives dictates the substitution of coatings containing less solvent for those high solvent coatings now in use. The development of such coatings has proceeded over the past few years and reduced-solvent coatings are at hand or expected soon. There are several kinds of coatings involved, with the composition of the coating dictated by the performance required by the application. There are antifouling coatings, non-skid coatings, deck paints, interior furnishing coatings, and a variety of others. A uniform 340 grams per liter limit appears feasible for each category.

EMISSIONS REDUCTION

The application of coatings and the associated use of solvents in shipyards contributed approximately 4.4 tons per day of ROG in 1985. In the years 2000 and 2010 emissions from this activity are expected to be 4.5 and 4.7 tons per day, respectively.

It is estimated that implementation of this measure would result in a net ROG emission reduction of about 33 to 50 percent. Thus, the

potentialemission reduction is 1.8 and 1.9 tons per day of ROG in the years 2000 and 2010, respectively.

COST EFFECTIVENESS

General application of the newly developed coatings will probably result in higher material costs, although the competitive nature of the industry will prevent unrealistic costing. Some economic coatings are superior to the old alkyds, to the extent that less frequent maintenance is needed. Based on analysis of similar types of coatings, the cost effectiveness of the measure is estimated to be about \$2,000 per ton of ROG reduced.

OTHER IMPACTS

No adverse effect on water quality of liquid or solid waste disposition is anticipated as a result of this measure. Some economic penalty could be imposed upon the local shipbuilding industry, if the proposed measure is implemented locally instead of nationally.

CONTROL OF EMISSIONS FROM ARCHITECTURAL COATINGS [ROG]

<u>SUMMARY</u>

Source Category: Architectural Coatings

Control Methods: Emission Charges on Users of Architectural Coatings

Emissions:
(Tons/Day)

ROG Inventory
ROG Reduction

Year 1985

Year 2000

Year 2010

49.7

Not Determined

Control Cost: Not Determined

DESCRIPTION OF SOURCE CATEGORY

Background

According to the 1985 emission inventory, architectural coatings accounted for 64 tons of daily reactive organic gas (ROG) emissions which were higher than any industrial coating processes. The small-scale and infrequent nature of architectural coating operations and the size of substrates make the installation of control equipment presently impractical. Unlike industrial coatings, emissions from architectural coatings are difficult to control by adding control equipment in the coating process. As a result, coating reformulation is currently being proposed to reduce ROG emissions from architectural coating applications.

The current available technology for architectural coatings is solvent-borne or water-borne. The extent to which various technology has been applied depends on types of coatings, due to their individual specifications. For example, there has hardly been any water-borne lacquer on the market, while non-flat coatings have been catching on the water-borne technology. The newly-emerged reactive diluent technology will produce nearly zero emissions from volatile organic compounds (VOC) during

the curing process because most of the VOC becomes an integral part of finished coatings through chemical reaction.

In order to promote further research and development for coating reformulation in reducing VOCs, incentives must be given to the coating manufacturers who will be making progress towards the development of new technology. Coating manufacturers who have not switched to the low-VOC technology will have their products assessed for emission charges. The money collected will be used for further research in coating reformulation.

Regulatory History

Rule 1113 sets various VOC limits for different types of architectural coatings. However, these limits do not encourage further VOC reductions below the specified limits. Hence, continuous emission reductions will not occur unless more stringent limits are given.

According to Senate-Bill 151 (Presley Bill), the District is required to submit a prototype emission charges rule by September 1, 1988 to the State Legislature. In the meantime, the District will seek the authority to use emission charges as an economic incentive system to improve air quality. Therefore, adoption of this control measure will have to depend on the attainment of authority to use emission charges.

Emission charges here are different from the District's current emission fees in Rules 301(e), 301.1(d), and 301.2(b). The purpose of these fee rules is to cover the costs of District's operations, in the area of planning, inspection, and monitoring. Time-specific and place-specific emission charges were proposed in the 1982 AQMP Revision, as outlined in control measures P13 and P14 respectively. However, they were not adopted.

PROPOSED METHOD OF CONTROL

Emission charges will be used to encourage coating manufacturers to move away from manufacturing coatings with higher VOC content and toward those with less VOC content through coating reformulation.

The current VOC limits on architectural coatings in Rule 1113 are used as threshold standards. A uniform and more stringent standard will be set as the goal standard for all types of architectural coatings. Charges on a per emission unit basis will be indexed to the additional costs of complying with the goal standard. Coating manufacturers whose products do not comply with the goal standard will have to assess emission charges to these products in order to market them in the Basin. As required in Rule 1113, coating manufacturers are not allowed to sell in the Basin coatings with VOC limits beyond those specified in Rule 1113. The elements in this proposed method of control are discussed accordingly.

Who Will Be Paying Emission Charges?

Emission charges will be imposed on coatings which have higher than the goal VOC standard. The labels on such coatings will carry messages such as "As user of this coating, you are charged for an extra amount of dollars because this coating has higher level of ozone-forming compounds. Your money will be used for financing research and development in further reducing such compounds." Consumers will be given a line of choices for coatings with various VOCs. However, they have to pay higher prices for coatings with high VOCs, in order for such coatings to remain in the market.

How to Set Emission Charges?

Currently, coatings with the solvent-borne technology can have VOCs as low as 250 grams per liter. The water-borne technology, according to a recent District's architectural coating survey, can further bring down VOCs to approximate 50 grams per liter. In the short run, the water-borne technology may offer more potentials to reduce VOCs in coatings. However, the long-run goal may be to produce coatings with few or no VOCs, pending the development of reactive diluent technology, or any other technology.

As such, 120 grams of VOCs per liter will be designated as the short-run goal standard and zero VOCs as the long-run goal standard. Coatings which do not comply with the goal standard will be assessed emission charges.

The amount of emission charges will be equal to unit charge rates (in dollars per pound of VOC) multiplied by the difference between actual VOCs in coatings and the goal standard (in pounds per gallon). There may be a single level or multi-level unit charge rate(s).

How to Ensure Proper Incentives Are Given?

Emission charges will be adjusted annually from the first year on to ensure prices of coatings with lower VOCs will not exceed prices of coatings with higher VOCs. Without proper adjustments, additional costs of moving into a reformulation producing lower VOCs could surpass emission charges imposed on the same type of coatings with higher VOCs, thereby defeating the purpose of using emission charges as incentives to facilitate air quality improvement. Two types of adjustments are necessary to avoid the occurrence of such disincentives and they are tied to:

o Previous year's inflation rate

o Previous year's ratio of coatings with emission charges to all architectural coatings sold in the District

Use of Emission Charges

The revenue collected from emission charges will be put in an escrow account and used to finance research and development to further reduce VOC

content. Persons and companies who can demonstrate low-VOC coating formulas are encouraged to apply for such research grants.

EMISSION REDUCTION

Emission reductions will depend on whether emission charges are set properly so as to offer enough incentives. The ratio of coatings with emission charges will be another determining factor in emission reductions.

COST EFFECTIVENESS

Implementation of new formulations may require different types of materials, such as resins, pigments, and solvents, for coating production. This may increase the cost of coating products.

OTHER IMPACTS

Emission charges which are set too high will create hardship on coating manufacturers and may cause uncompetitive ones to go out of business. Coatings with reduced VOC content may require more coats, frequent paint jobs, more drying time, or changes in paint applications.

FURTHER EMISSION REDUCTIONS FROM PAPER, FABRIC, AND FILM COATING [ROG]

<u>SUMMARY</u>

Source Category: Paper, Fabric and Film Coating Operations

Control Methods: Low Solvent Coatings; Recordkeeping

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 23.5 | 24.4 | 25.5 0.3 |

Control Cost: \$5,000 Per Ton of ROG

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

In the Basin, there are 36 facilities engaged in paper, fabric, or film coating. Each of these coating processes are briefly described below.

Paper coating includes the coating of adhesive tapes and labels, book covers, post cards, office copier paper, drafting paper, pressure sensitive tape and other forms of paper. In paper coating operations, resins are dissolved in an organic solvent or solvent mixture and this solution is applied to a continuous roll of paper. As the coating roll dries, solvent evaporates and the coating cures. These coatings are applied for a variety of decorative and protective purposes.

Fabric coating includes the coating of vinyl fabric sheets for wall paper and the impregnation of woven glass fabrics with epoxy, polyester and other resins. Fabric coating involves the coating of a textile substrate to impart properties that are not initially present, such as strength, heat resistance, and mechanical stability. Fabric is usually coated by either a knife or a roller coater. Both methods are basically spreading techniques used for high speed application of coatings to flat surfaces.

Film coating is any coating applied in a web coating process on any film substrate other than paper or fabric such as typewriter ribbons, photographic paper, magnetic tape, and metal foil gift wrap. As with paper coating operations, coatings are usually applied to a continuous roll of material to be coated.

Generally, ROG emissions in all three operations occur in the coating area, the preheat and baking zones, and as the coated surface dries.

Regulatory History

Emissions from papar fabric and film coating operations are currently regulated under District Rule 1128 which establishes VOC limits for coatings and clean-up solvents used in these coating processes. District Rule 1128 also contains a provision which allows the use of non-complying coatings if comparable emissions reductions can be achieved through alternative control methods, namely the use of add-on emission control technology.

PROPOSED METHOD OF CONTROL

The emission limitation requirements of Rule 1128 currently apply to those companies whose coating operations involve the use of heating ovens. When the Rule was developed, there were no companies that did not heat dry their products. There is now one company that no longer heat dries its material and is subject to Rule 442. The term "involving the use of heating ovens" could be deleted from Rule 1128 as a criterion for rule applicability to achieve further ROG emission reductions.

It is also proposed that facilities be required to submit daily records of coating and solvent usage, the VOC content of coatings used, and operating parameters of control equipment. This would facilitate compliance and evaluation.

EMISSIONS REDUCTION

Paper, Fabric, and Film Coating operations resulted in approximately 23.5 tons per day of ROG in 1985. Emission estimates for 2000 and 2010 are 24.4 and 25.5 tons per day, respectively.

Implementation of this control measure will result in an overall emission reduction of about 1 percent. Thus, this measure could achieve an ROG reduction of 0.2 tons per day in 2000 and 0.3 tons per day in 2010.

COST EFFECTIVENESS

The cost effectiveness of meeting the proposed requirements for this source category is \$5,000 per ton of ROG reduced.

OTHER IMPACTS

No adverse impacts are expected from this measure.

FURTHER EMISSION REDUCTION FROM GRAPHIC ART OPERATION [ROG]

SUMMARY

Source Category: Graphic Arts Industries

Control Methods: Demonstrate Daily Compliance; Recordkeeping

Emissions: (Tons/Day) Year 1985 Year 2000 Year 2010 ROG Inventory 5.9 4.8 5.0 ROG Reduction Minor Minor

Control Cost: Minor Administrative Cost for Compliance and

Recordkeeping

Other Impacts: Minor Administrative Impact on District Due to

Additional Manpower Requirement for Enforcement

DESCRIPTION OF SOURCE CATEGORY

Background

The graphic arts industry is made up on five principal types of printing processes: letterpress, lithography, flexography, rotogravure, and screen printing. Each of these processes involve the printing of a relatively high solvent content material (ink) onto either porous or non-porous substrates; rapid solvent evaporation; and solvent laden air exhausted from the system.

Emissions from graphic art operations consist primarily of volatile organic solvents. The source of these solvents are from the use of solvent base inks and any other graphic arts materials such as coatings, adhesives, fountain solutions, thinners, retarders, and cleaning solutions used in printing or related coating or laminating processes. Rotogravure and flexography, applied in publication and packaging printing, use very fluid inks containing high quantities of volatile organic solvent, 55 to 95 volume percent with an average of 75 percent (USEPA, 1981).

Although some of the solvent in these materials may be absorbed into the

substrate, most of the solvent eventually evaporates when the materials cure. Emissions from curing of graphic art materials occur either in the drying oven or as fugitive emissions from the ink fountain and rollers. Incinerators and carbon adsorbers are the most desirable control devices that have a high efficiency in controlling vapors from printing operations.

Although major sources contribute most of the emissions for graphic arts operations, considerable emissions are also originated from minor (small) sources (emitting less than 20 pounds VOC per any one day). The proposed control measure herein is directed toward the small sources as well as compliance improvement by the large sources under the existing rule.

Regulatory History

ROG emissions from the graphic art industry are currently regulated under District Rule 1130. This rule establishes both control and operating requirements. Printing processes on porous substrates are required to use low solvent technology or operate a control system with at least a 95 percent efficiency. Printing processes on non-porous substrates are required to use low solvent technology or operate a control system with at least a 90 percent control efficiency. At present the Rule requires daily compliance and record keeping by large sources and allows variable averaging periods for minor sources.

PROPOSED METHOD OF CONTROL

The proposed method of control is to require daily compliance and record keeping for small sources.

EMISSIONS REDUCTION

It is estimated that graphic art printing processes account for approximately 5.9 tons per day of ROG in 1985. The ROG emissions in the years 2000 and 2010 are expected to be 4.8 and 5.0 tons per day, respectively. This measure will not result in direct emissions reductions, but should improve enforcement and compliance with Rule 1130.

COST EFFECTIVENESS

Implementation of this measure will result in minor administrative costs for affected facilities.

OTHER IMPACTS

There will be minor administrative impact on District due to additional manpower requirement for enforcement.

REFERENCES

U.S.Environmental Protection Agancy. 1981. <u>Compilation of Air Pollutant Emission Factors</u>. April 1981.

SUBSTITUTE SOLVENTS USED FOR CLEAN-UP OF SURFACE COATING [ROG]

<u>SUMMARY</u>

Source Category: Clean-up Solvents

Control Methods: Substitute Solvents; Improved Procedures

Emissions:
(Tons/Day)

ROG Inventory
ROG Reduction

13.0

13.6

14.6

10.2

11.0

Control Cost: \$1,100 Per Ton of ROG

Other Impacts: Increased Emissions and Exposure to Toxic

Air Contaminants

DESCRIPTION OF SOURCE CATEGORY

Background

For most surface coating operations, solvent is used to clean and maintain application equipment, spray booths and other materials used in the coating process. Although the volume of solvent used for this purpose may often be minor in comparison to the amount of solvent utilized in the coating process, ROG emissions from cleanup operations from all surface coating process operations in the Basin amount to a significant source of emissions.

Cleanup solvents are regulated under Rule 442. This rule classifies a solvent as either photochemically or non-photochemically reactive, based on the volume percentages of individual components in the solvent. This classification is then used to determine the degree of control. Photochemically reactive solvents are limited to 7.9 pounds per hour (not to exceed 39.6 pounds per day) and non-photochemically reactive solvents are limited to 81 pounds per hour (not to exceed 600 pounds per day). Heat cured or heat baked materials are limited to 3.1 pounds per hour (not to exceed 14.3 pounds per day).

PROPOSED METHOD OF CONTROL

This control measure aims to achieve additional ROG reduction from requiring the use of lower vapor pressure cleanup solvent and/or water-based cleanup formulations in place of conventional petroleum-based formulations. This measure applies to all surface coating operations and would involve establishing either a Rule 442 type regulation which addresses cleanup operations and/or amending each rule which regulates a specific coating operation.

Lower VOC cleanup solvents are currently required for several industries in the Basin. Current requirements specify the use of cleanup solvents which have a composite vapor pressure of 45 mm Hg or a VOC content of 200 grams per liter or lower. Preliminary analysis shows that these cleanup solvents could be used in other operations. Moreover, improved procedures can also be used during solvent handling. This measure proposed expanding the use of less-polluting solvents and improved procedures to all source categories.

EMISSION REDUCTION

Cleanup processes from all surface coating operations emitted approximately 13.0 tons per day of ROG in 1985. In the years 2000 and 2010 emissions from theses activities are expected to reach 13.6 and 14.6 tons per day. This measure can provide an emissions reduction of about 75 percent. Therefore, the predicted maximum reduction in the years 2000 and 2010 are 10.2 and 11.0 tons per day. It should be noted, however, that there is considerable overlap between this measure and several of the others.

COST EFFECTIVENESS

This measure proposes two actions: use of less-polluting solvents and improved handling procedures. Improved handling procedures reduces material usage and thereby results in a cost savings. Less-polluting formulations generally cost more than conventional formulations and have a cost-effectiveness of about \$1,100 per ton of ROG reduced.

OTHER IMPACTS

The cleanup solvents formulated to meet the proposed requirements have been composed of a blend of solvents, including 1,1,1 trichloroethane and methylene chloride (Turco, 1986). Methylene chloride is considered to be a probable human carcinogen and is currently under investigation by EPA and therefore, increase the emissions of and exposure to toxic air contaminants.

There may also be occupational health problems involved in making the

substitution. When Northrop Corporation first switched to the use of the lower vapor pressure solvents to comply with Rule 1124, assembly workers complained of the smell (Northrop, 1986).

REFERENCES

Turco Corporation. 1986. Personal communication with M. Price, 1986.

Northrop Corporation. 1986. Personal communication with M. Price, 1986.

FURTHER EMISSION REDUCTIONS FROM METAL CLEANING AND DEGREASING [ROG]

<u>SUMMARY</u>

Source Category: Metal Cleaning and Degreasing

Control Methods: Add-on Controls; Posted Operating Requirements;

Increased Freebroad Ratio; Eliminating Exemption;

Outreach Program

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 23.3 | 31.6 | 35.7 |
| ROG Reduction | | 15.8 | 17.9 |

Control Cost: \$3,000 to \$25,000 Per Ton of ROG

Other Impacts: Increased Emissions and Exposure to Toxic Air

Contaminants

DESCRIPTION OF SOURCE CATEGORY

Background

Solvent degreasing is practiced throughout the Basin in thousands of locations, mainly in manufacturing and maintenance operations (i.e. automotive repair shops, oil well field operations, aerospace and electronics, and railroad maintenance yards). The ubiquitous nature of emissions from these activities can be compared to gasoline dispensing in the Basin.

Degreasing is done as a preparatory step to subsequent operations such as coating, plating, repair, assembly, and machining. Degreasing is generally carried out in packaged degreaser units in which a chlorinated synthetic solvent or petroleum-based solvent is utilized to remove contaminants. There are three basic types of organic solvent degreasing: cold cleaning; open top vapor degreasing; and conveyorized degreasing (SCAQMD, 1981). Each of these different types of degreasing is briefly described below.

Cold degreasing is the simplest and least costly degreasing method. It consists of a solvent tank in which the work is immersed in solvent, which may be heated, but always remains below its boiling point. Most cold degreasers have a tank surface of 1.0 m2 or less. Cold solvent degreasers most often utilize highly reactive petroleum based solvents (stoddard solvent) (SCAQMD, 1983). The nonreactive solvents such as 1,1,1 trichloroethane, methylene chloride, and the freons, as well as perchloroethylene (PCE), are also used, albeit to a much lesser degree. Solvent emissions from these types of degreasers can occur due to direct evaporation from the tank and during spills, and evaporation from drag-out.

Vapor degreasing differs from cold solvent degreasing in that boiling organic solvents are used and the parts to be cleaned are degreased in the solvent vapors above the liquid solvent. Cooling coils near the top of the degreaser condense the solvent vapors, and reduce the chances of its evaporation into the atmosphere. Vapor degreasers generally utilize solvents of low reactivity such as PCE or the non-reactive solvents mentioned above (SCAQMD, 1983).

Conveyorized degreasing uses cold cleaning or vapor degreasing in a continuous process with conveyor systems used to move the work into and out of the degreaser. The major emissions from this type of degreaser are from drag-out evaporation and evaporation from the solvent tank. Most of the emissions from these degreasers are PCE (SCAQMD, 1983).

Regulatory History

Emissions from degreasing operations are regulated under Rule 1122. The rule establishes both equipment and operating requirements for degreasing units. Amendment of this rule to achieve additional emission reductions has been deferred pending EPA's decision on the reactivity of PCE.

Decision on PCE's toxicity is also pending. Both EPA and ARB are currently reviewing the toxic nature of the solvent and whether exposure to it causes cancer. A finding that perchloroethylene is carcinogenic may require the District to adopt additional measures limiting its ambient concentration.

PROPOSED METHOD OF CONTROL

Further emission reductions can be achieved by posting operating requirements, specifying a maximum ventilation rate for all degreasers, minimizing solvent drag-out losses, eliminating certain exemptions in Rule 1122, expanding the scope of Rule 1122 to include smaller cold degreasers and further restricting the solvent content in waste materials. An outreach program for degreaser operators is also proposed. Specific means of achieving further emission reductions are outlined below.

o Rule 1122 currently specifies a maximum ventilation rate of m/min in work areas to minimize evaporative emissions from remote reservoir cold cleaners since the units are usually equipped with exhaust fans.

The specified ventilation rate could be expanded to include all degreasers in the work area, and is aimed at achieving lower exhaust volumes at higher ROG concentrations. Compliance with OSHA regulations must also be maintained. Emission reductions must also be maintained. Emission reductions resulting from this approach are difficult to estimate and require further study.

- o Rule 1122 establishes various requirements directed at the operation of degreasers to minimize emissions. Compliance with these requirements could be improved by requiring operators to post an "operating requirements" label. Emission reductions resulting from this approach are difficult to estimate and require further study.
- Rule 1122 currently specifies a maximum ventilation rate of 40 m/min in work areas to minimize evaporation emissions from remote reservoir cold cleaners since the units are usually equipped with exhaust fans. The specified ventilation rate could be expanded to include all degreasers in the work area, and is aimed at achieving lower exhaust volumes at higher ROG concentrations. Compliance with OSHA regulations must also be maintained. Emission reductions resulting from this approach are difficult to estimate and require further study.
- Further reductions may be achieved by minimizing drag-out losses from cleaning intricately or irregularly shaped parts. Such parts trap solvent in crevices or hollow areas with the solvent then being lost to the atmosphere. One approach may be to require that such parts only be cleaned in detergent or other nonsolvent formulations. The outreach program discussed below may result in identifying other approaches which would lead to elimination of such losses.
- Rule 1122 currently exempts vapor degreasers which exclusively 0 utilize PCE from the more stringent requirements of the Rule. Specifically, vapor degreasers are exempt from installing a refrigerated freeboard chiller and/or carbon adsorption unit. exemption could be eliminated to provide further emissions reductions. Another means of achieving emissions reductions is to require 100 percent free-board ratio on vapor and conveyorized degreasers. Currently for open-top vapor and conveyorized degreasers, a free-board ratio (the free-board height divided by the smaller of the length or width of the degreaser) of 0.75 is required. Preliminary analysis by staff shows that increasing the free-board ratio from 75 percent to 100 percent can reduce emissions (primarily PCE and exempt solvents) by 20 percent. For both of these types of degreasers, increasing the free-board ratio involves bolting an additional metal sheeting around the solvent tank surface (Detrex Corp., 1986). In some instances, physical space above the degreaser may prohibit this modification. The addition of a carbon adsorber can result in an overall emission reduction of 50 percent. This 50 percent reduction is in addition to any reduction achieved through other measures. The carbon bed of the adsorber does need periodic

maintenance for which steam is required. A steam facility is therefore necessary which may pose physical space problems at some sites.

- Nearly all of the remaining non-perchloroethylene emissions in this source category are from small cold solvent degreasers located in thousands of facilities throughout the District (SCAQMD, 1983). These degreasers most often have a tank surface area less than 1.0 m², and as such, are not required to have a permit. They are, however, still subject to the equipment requirements (a free-board ratio of 75 percent or a water cover), and operating requirements of Rule 1122. The remaining emissions from these degreasers can be reduced by three ways: requiring the use of exempt solvents (i.e. 1,1,1 trichloroethane, methylene chloride, or freon); requiring 100 percent free-board ratio on all units; and/or requiring that such units be replaced with alkaline, emulsion cleaners or other type of cleaning devices which do not rely on petroleum or synthetic based solvents (Allklean, Inc., 1986). In order to enforce such a requirement, permits may need to be issued for such equipment.
- Currently, the amount of solvent in waste materials is regulated by DOHS rules. Its limits can generally only be achieved by contracting with solvent recyclers equipped with special distillation units. EPA Region IX has recommended restricting the solvent content in waste materials to 10 percent. Since most degreaser operators do not have stills, District staff believes a more meaningful requirement would be to simply state that solvent must be disposed of in compliance with DOHS regulations. This gives the operator the option of reducing solvent in waste material, either by his own still or by shipment to a solvent recycler. This means of achieving emissions reduction is further addressed in the control measure #88-A-20 "Control of Emissions From Solvent Wastes."
- Finally, excess ROG emissions from drag-out and improper maintenance of the units could be further reduced through an outreach program which includes training courses and/or workshops on the proper operation and maintenance of degreasers. This outreach program could be co-sponsored by local county sanitation districts, the state Department of Health Services, and other regulatory agencies which regulate the use and disposal of solvents by manufacturing and maintenance industries.

EMISSION REDUCTIONS

Solvent cleaning and degreasing operations emitted approximately 23.3 tons per day of ROG in 1985. Emissions from these activities in the years 2000 and 2010 are expected to reach 31.6 and 35.7 tons per day, respectively

The approaches listed above will reduce emissions by 15.8 tons per day in the year 2000 and 17.9 tons per day in the year 2010. These reductions are

estimated as described below.
Raising the freeboard ratio on vapor and conveyorized degreasers will result in a 20 percent emission reduction. An additional 50 percent reduction of 60 percent of the emissions will result from the installation of carbon adsorbers on the larger degreasers (SCAQMD, 1983). A 50 percent reduction factor was used to estimate reductions from cold solvent cleaning, if these activities are brought under permit requirements. The other proposed requirements are expected to provide additional reductions, the extent of which is however, difficult to quantify. It is also difficult to quantify reductions achieved through switching to nonreactive solvents as there is no way of knowing how many operators would do so.

COST EFFECTIVENESS

Implementation of the proposed requirements would result in capital expenditures by operators of degreasers for additional control equipment, or increased operating costs due to using more expensive nonreactive solvents. For the operator required to install a carbon adsorber, the average cost effectiveness is estimated at \$10,000 per ton of ROG reduced. Raising freeboard ratio to 100 percent yields an estimated cost effectiveness of \$200 per ton of ROG reduced. Switching from PCE to 1,1,1 trichloroethylene results in an estimated cost effectiveness of \$3,000 or ROG per ton reduced and switching to flourinated solvent results in \$25,000 of ROG per ton reduced.

OTHER IMPACTS

Implementation of the proposed requirements may result in some degreaser operators switching to one of the exempt, nonreactive solvents, rather than installing additional control equipment. Methylene chloride, an exempt nonreactive solvent, is currently considered a "probable human carcinogen" by the U.S. EPA. Other exempt solvents may also be classified as toxic air contaminants in the future. Absent any control measures specific to these solvents, emissions of toxics may increase.

Another consideration is the substitution of Freon compounds for ROG's. These compounds are suspected of inducing degradation of the stratospheric ozone. Large scale substitution with exempt solvents, such as Freon 113 may be of concern in the future with respect to global air quality concerns, as opposed to regional.

Requiring permits for cold solvent degreasers poses an administrative impact upon the District. Additional enforcement and engineering resources would be required for such permits.

REFERENCES

South Coast Air Quality Management District. <u>Rule 1122 - Solvent Metal</u> <u>Cleaning (Degreasing)</u>. Staff Report. EL Monte, CA.

SCAQMD. 1983. <u>Proposed Amended Rule 1122 - Solvent Cleaners (Degreasers)</u>. Staff Report. Rule Development Division. El Monte, CA. May 25, 1983.

Detrex Corp. 1986. Personal communication with Jack Broadbent, 1986

Allklean Inc. 1986. Personal communication with Jack Broadbent, 1986.

CONTROL OF EMISSIONS FROM RIGID AND FLEXIBLE DISC MANUFACTURING OPERATION [ROG]

SUMMARY

Source Category: Rigid and Flexible Disc Manufacturing

Control Methods: Covers for Coating-Mixing Vats;

Low-VOC Formulations

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 2.0 | 2.8 | 3.0 |
| ROG Reduction | | 2.4 | 2.5 |

Control Cost: \$3,000 to \$3,500 Per Ton of ROG

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

In the manufacture of magnetic data storage discs, three operations result in ROG emissions. These operations include coating mixing, disc coating, and disc polishing. Each of these processes are briefly described below.

A variety of mixing vats are used for preparing the magnetic coatings used in disc manufacturing. These vats are sources of fugitive ROG emissions from solvent evaporation.

Disc coating involves applying a magnetic coating to flat, circular disc substrate materials for storage of digital information. The magnetic coatings contain organic solvents that evaporate and are emitted to the

Disc polishing is a physical rubbing process with an organic solvent on coated discs to increase surface smoothness and gloss. The organic solvents used in the polishing process evaporate from the units and are emitted to the atmosphere.

Regulatory History

The measure proposed herein is based on the Bay Area Air Quality Management District's (BAAQMD) Regulation 8, Rule 38 "Flexible and Rigid Disc Manufacturing". The BAAQMD is developing a suggested control measure for this source category for the statewide Technical Review Group based on its rule (BAAQMD, 1985).

PROPOSED METHOD OF CONTROL

This measure proposes operating and control requirements to reduce ROG emission from these operations. ROG emissions from coating-mixing vats can be controlled through the proper use and maintenance of covers. ROG emissions from disc coating and polishing operations can be reduced through the installation of control devices and/or use of low-VOC coating and polishing formulations. According to the BAAQMD, low-VOC formulations are currently under development by disc manufacturing facilities.

EMISSIONS REDUCTION

It is estimated that magnetic disc manufacturing in the Basin contributed approximately 2.0 tons per day of ROG emission in 1985. The emission estimates for the years 2000 and 2010 are 2.8 and 3.0 tons per day, respectively. The BAAQMD rule results in 85 percent control of the companies affected (Stone, 1988). It is therefore estimated that the potential emissions reduction from this measure would result in about 2.4 and 2.5 tons of ROG per day of ROG reductions in the years 2000 and 2010.

COST EFFECTIVENESS

The cost-effectiveness of implementing this rule is \$3,000 to \$3,500 per ton of ROG reduced, as determined by the BAAQMD (Stone, 1988).

OTHER IMPACTS

No adverse impacts are expected from this measure.

REFERENCES

Bay Area Air Quality Management District. 1985. "Board letter from the Air Pollution Control Officer to Chairperson Silver and Members of the Board of Directors at the BAAQMD, Regarding Public Hearing to Consider Proposed Regulation 8, Rule 38". September 25, 1985.

Stone, Greg. 1988. BAAQMD. Personal communication with Larry Irwin, February 5, 1988.

CONTROL OF EMISSIONS FROM EXPANDING PLASTICS AND BLOWING FOAM MANUFACTURING OPERATION [ROG]

SUMMARY

Source Category: Expanded Plastics and Blown Foam

Control Methods: Add-on Controls

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 3.8 | 5.2 | 5.7 |
| ROG Reduction | | 4.2 | 4.6 |

Control Cost: \$2,100 Per Ton of ROG

Other Impacts: Increased Fuel Use; Increased NO_X Emissions; Increased Generation of Solid/Liquid Waste

DESCRIPTION OF SOURCE CATEGORY

Background

Low density porous plastics (foams) are used extensively for packaging, thermal insulation, cushioning, food containers, drinking cups, boat and vehicle parts, and simulated wood furniture parts. The foam may be rigid or flexible and vary in strength dependent upon application. In the manufacture of the foam a resinous liquid or solid and gas evolving materials are used. The process where the resin expands to form the foam is "foam blowing" and the material which creates the gas is the "blowing agent." For this control measure pentane and related hydrocarbons are the ROG blowing agents to be controlled. Other blowing agents such as chloroflurocarbons, air frothing, methylene chloride, and chemically generated carbon dioxide, may also be used in manufacturing foam, but are not targeted by this measure.

The process of manufacturing foams using pentane involves preparation of material, polystyrene slurry. Pentane is dissolved or adsorbed within the void spaces of the resulting fine particles. These are loaded with about 7 percent by weight pentane. To expand or blow foam, these fine particles are heated with steam and expanded to obtain large beads. Upon confining these beads in a mold fixture and softening by heating, a block or molded foam object can be obtained. Articles such as drinking cups, simulated wood beams, flexible packing cushions, and flotation blocks are some of the final products.

Regulatory History

The ROG emissions from existing foam blowing operations are not controlled by any regulation. For new facilities, the EPA Lowest Achievable Emission Reduction (LAER) requirement would be carbon adsorption, catalytic incineration, or some innovative methods to control the ROG.

PROPOSED METHOD OF CONTROL

The emissions from foam blowing can be controlled by collecting the ROG emissions in a carbon adsorption unit or by burning directly in a catalytic incinerator. The ROG emissions are usually suitable for such operations because of relatively high concentrations at about 1500 ppm by volume. The catalytic incineration requires uncontaminated cleaned vapors. This may require filtering out the plastic particles in the vapors from the process. The foam blowing may be the popcorn type steam expansion of suspension polymers with dissolved pentane, or the partial polymerization expansion followed by molding or extrusion into porous solid shapes. Collecting the pentane vapors (or other ROG blowing agents) would require an enclosure and ducting to convey the vapors to an incinerator or carbon adsorption train. The overall ROG control efficiency can be over 80 percent.

EMISSIONS REDUCTION

Foam blowing currently contributes about 3.8 tons per day of ROG. The largest single source has ROG emissions of one ton per day. About 30 sources are identified, but it is estimated that many other small and intermittent sources may be significant. The emissions estimated for the years 2000 and 2010 are 5.2 and 5.7 tons per day, respectively. With 80 percent control efficiency, about 4.2 tons per day ROG reduction would be expected in 2000 and 4.6 tons per day in 2010.

COST EFFECTIVENESS

Assume a facility with an exhaust velocity of 300 cfm, pentane concentration of 1,500 ppm, and daily emissions of 82 lbs. To install a thermal oxidizer, the first year cost is \$120,000. With a 50 percent heat exchange and with heat contribution from ROG destruction, annual operation costs - mainly natural gas and electricity costs - are \$11,000. The cost effectiveness for such facility, assumed to be representative of this source category, would be \$2,100.

OTHER IMPACTS

The supplemental addition of fuel to operate the incinerators will increase fuel use, which can be minimized if the waste heat is collected and used to displace the normal heat supply. NO_{χ} emissions may increase from the use of incineration. Additional generation of solid/liquid waste may result.

REFERENCES

Wilson, Hubert. 1987. South Coast Air Quality management District, Engineering Division. Personal communication, August 1987.

CONTROL OF EMISSIONS FROM SEMICONDUCTOR MANUFACTURING OPERATION [ROG]

<u>SUMMARY</u>

Source Category: Semiconductor Manufacturing.

Control Methods: Add-on controls; Housekeeping Improvements;

Conversion to Positive Photoresist

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> | |
|--------------------------|------------------|------------------|------------------|--|
| ROG Inventory | 2.0 | 2.8 | 3.0 | |
| ROG Reduction | | 2.4 | 2.6 | |

Control Cost: \$2,300 Per Ton of ROG

Other Impacts: Increased Fuel Use; Increased NO_x Emissions from

Incineration; Increased Generation of Solid or

Liquid Waste

DESCRIPTION OF SOURCE CATEGORY

Background

The manufacture of semiconductors involves several steps, some of which rely on the use of organic solvents. Specifically, these steps include wafer production, wafer oxidation, and photolithography. The production and oxidation of wafers is only performed by a limited number of companies located in Santa Clara (Silicon) Valley in Northern California. In the South Coast Air Basin, there are approximately 50 companies which operate photolithographic processes to create integrated circuits. These include both merchant producers which supply aerospace, computer, and other users of semiconductors for the assembly of circuit boards, and captive producers which operate their own photoresist operations for their specific product line.

Two basic photolithographic processes are used in semiconductor manufacturing: positive photoresist and negative photoresist. Negative photoresist operations involves the application of maskant and exposing

patterns of this solution to light. Unhardened maskant is stripped, exposing wafer surface to etching. Negative photoresist operations use reactive solvent (mostly xylene), formulated resin, and developer solutions.

In recent years positive photoresist has become more widely used. The resolution achievable using positive photoresist is about twice that obtained using negative. This is a considerable incentive for most manufacturers to switch. Positive photoresist uses nonreactive (cellosolve) formulations as photoresist solvent instead of xylene, and uses an inorganic developer instead of a solvent developer. Emissions of organic compounds from positive photoresist are approximately one-tenth those from negative photoresist.

Regulatory History

At present, the District does not have a source-specific rule for semiconductor manufacturing facilities. The emissions from these operations are currently only limited under Rule 442. The Rule's limiting value are directed toward large volume operations. Not much photolithographic equipment emit more than the limits currently in place under Rule 442.

The Bay Area Air Quality Management District (BAAQMD) has adopted Regulation 8, Rule 30 which is specifically directed at VOC emissions from semiconductor manufacturing operations. Currently, the BAAQMD is developing a suggested model rule for the statewide Technical Review Group of the California Air Pollution Control Officers Association.

PROPOSED METHOD OF CONTROL

Emissions from semiconductor manufacturing operations can be reduced by: (1) controlling emissions from photoresist operations by 90 percent and (2) controlling emissions from solvent cleaning stations. Regulatory proposals for each of these control approaches are outlined below.

- Require that all negative photoresist operations be controlled by at least 90 percent. This can be achieved by a number of means including conversion to positive photoresist, installation of add-on control devices (i.e. carbon adsorption, incineration), and/or housekeeping improvements which result in lower solvent usage and/or evaporation. At present, incineration seems the most likely method to be applied short of converting to positive photoresist.
- Require that emissions from solvent cleaning stations be reduced by 77 percent. Since emission controls for this type of equipment are addressed in CM #88-A-12, the regulatory proposals are detailed there.

EMISSIONS REDUCTION

Semiconductor manufacturing operations resulted in approximately 2.0 tons of ROG per day, in 1985. Emission estimates for 2000 and 2010 are 2.8 and 3.0 tons per day, respectively.

Implementation of the requirement to reduce emissions from photoresist operations by 90 percent, and from cleaning operations by 77 percent, will reduce emissions by 2.4 tons per day in the year 2000 and 2.6 tons per day in the year 2010. Reductions from solvent cleaning stations are addressed in CM #88-A-11.

COST EFFECTIVENESS

Implementation of the requirement to reduce emissions from photoresist operations will result in capital expenditure by the semiconductor manufacturers. The average cost effectiveness is estimated at \$2,300 per ton of ROG emissions reduced when an incineration system is used. The cost effectiveness is estimated at \$50,000 per ton of ROG emissions reduced when switching from negative to positive photoresist. However, as already noted, there are product improvements which result from such a switch.

OTHER IMPACTS

Increased auxiliary fuel consumption and ${\rm NO_X}$ emissions can result from incinerator operation. The use of add-on control devices may increase generation of liquid or solid waste.

REFERENCES

Bay Area Air Quality Management District. 1985. <u>Emissions From Semiconductor Plants</u>. BAAQMD Staff Report. February 8, 1985.

FURTHER EMISSION REDUCTIONS FROM PERCHLOROETHYLENE DRY CLEANING OPERATION [ROG]

<u>SUMMARY</u>

Source Category: Perchloroethylene Dry Cleaning

Control Methods: Replacement of Transfer System with Dry-to-Dry;

Eliminating Exemptions

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 15.7 | 21.6 | 24.5 |
| ROG Reduction | | 5.4 | 6.1 |

Control Cost: \$3,000 Per Ton of ROG

Other Impacts: Reduced Emissions of Potentially Toxic Air

Contaminant

DESCRIPTION OF SOURCE CATEGORY

Background

Approximately 1,760 establishments are engaged in perchloroethylene (perc) dry cleaning in the Basin (SCAQMD, 1986). They include small neighborhood dry cleaning shops operating on an independent basis, the franchise dry cleaning shops, and the specialty cleaners which handle leather and other fine goods.

Perc dry cleaning generally involves three principal steps, identical to those of ordinary laundering in water: one or more washes in solvent; extraction of excess solvent by spinning; and drying by tumbling in an air stream. There are two basic types of dry cleaning systems: (1) transfer systems—those in which washing and spinning is done in a different machine from drying; and (2) dry-to-dry systems—those in which washing and drying are done in a single unit. Emissions of perc solvent vapors can occur during wash, spin, or dry cycles, as well as during transferring operations—when garments laden with perc solvent are exposed to the atmosphere while being transferred from the washer to the dryer (transfer

systems only), or from the dryer to storage (both systems - when the garments are not completely dry).

Regulatory History

Emissions from perc dry cleaning systems are currently regulated under Rule 1102.1. This rule requires that facilities that use 320 gallons or more of perc per year must vent all exhausts from cleaning equipment and floor pick ups through a carbon adsorber, refrigerated condenser, or other control devices capable of achieving similar control efficiency.

The measure proposed herein is based, in part, on Measure G3 of the 1982 AQMP Revision. Measure G3 proposed the substitution of less polluting dry cleaning equipment for current systems in place (SCAQMD,1982). Rulemaking was delayed pending EPA's decision regarding the reactivity of perc. This decision is still under consideration by EPA. Measure G3 is, nevertheless, reintroduced herein, along with an additional means of reducing ROG emissions from perc dry cleaning systems.

Also pending are decisions by ARB and EPA as to perc's toxicity. Upon a finding by these agencies that the solvent is a toxic or carcinogenic air contaminant, the District may adopt additional measures limiting its concentrations in the ambient air.

PROPOSED METHOD OF CONTROL

Emissions from perc dry cleaning systems can be reduced through (1) replacing existing transfer equipment with new "closed" or "ventless" dry-to-dry machines and (2) eliminating the current small user exemption. Regulatory proposals for each of these primary control approaches, as well as two others, are outlined below.

- Require operators of all existing transfer equipment to replace it with "closed" or "ventless" dry-to-dry equipment. This would eliminate solvent emissions during transfer of garments from the washer to the dryer. Overall solvent emissions would be reduced by 50 percent. It should be noted that only about half the number of loads in the same amount of time can be cleaned in a dry-to-dry machine versus a transfer system. For this reason, some operators who replace their transfer systems with dry-to-dry may either have to operate the equipment for longer hours, purchase a comparatively larger dry-to-dry machine, or purchase multiple dry-to-dry machines in order to do the same amount of business.
- o Require proper operation of carbon adsorber unit by completing the desorption cycle. Replacement of the transfer units with dry-to-dry equipment (generally using refrigerated condensers rather than carbon adsorbers) will also reduce emissions from improper operation of the carbon adsorber units.

- o Require record keeping of all solvent usage and maintainence (e.g., carbon adsorber operation) for all sources.
- Eliminate the exemption which allows operators who use less than 320 gallons per year of solvent to operate without control equipment. This would mean that the proposal outlined above would also apply to the small user. For a small user who currently operates a transfer system without a control device, switching to a new dry-to-dry machine would result in a 75 percent emission reduction. Many small users, as a result of previously installing a carbon adsorber onto their transfer equipment, are currently operating below the exemption level. However, they would also be required to switch to dry-to-dry machines and would result in a 50 percent emission reduction. facilities operating at below the exemption level already employ the new "ventless" dry-to-dry units because using such units allow a very ready means of complying with the BACT requirement of New Source Review to which all new dry cleaning facilities are subject regardless of their solvent consumption (SCAOMD, 1987).
- Require that operators place "green" garments (garments that are not yet completely dry) into a cabinet which is vented to a control device or one that does not allow the escape of solvent vapors to the atmosphere. Occasional production demands may compel operators to cut short the drying cycle and remove garments early. Space constraints may pose problems at some sites. This proposal requires further study as does an alternative proposal requiring a lock-out device which would prevent the early removal of garments.
- Require that operators install and maintain a hydrocarbon detector at the outlet of their control device. The purpose of the device would be to either warn the operator and shut the system down in case of control failure, or at least indicate that maintenance is required. Such devices are not yet generally available, but may be in the near future.

EMISSIONS REDUCTIONS

Perchloroethylene dry cleaning operations resulted in approximately 15.7 tons per day of ROG in 1985. Emission estimates for 2000 and 2010 are 21.6 and 24.5 tons per day, respectively. Requiring that transfer equipment be replaced with dry-to-dry, including currently exempt dry cleaners, will reduce half of the current emissions inventory by 50 percent. Thus, the approaches listed above will reduce emissions by 5.4 tons per day in the year 2000 and 6.1 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed requirements would result in capital expenditures by dry cleaning operators. The cost effectiveness for the

average dry cleaner is estimated at \$3,000 per ton of ROG reduced. Depending on the additional control equipment required, the cost effectiveness ranges from \$1,000 to \$7,000 per ton of emissions reduced. The operator already using a dry-to-dry machine, but without a control device will likely encounter the lower estimate upon installation of a refrigerated condenser. The drycleaner who chooses to install two new dry-to dry machines or a large capacity machine will encounter the higher estimate.

OTHER IMPACTS

Perchloroethylene has been found to be carcinogenic in animal studies and the risk it may pose to humans is currently under evaluation by the California Department of Health Services and the U.S. Environmental Protection Agency. These proposed requirements will reduce emissions of, and exposures to, a potentially toxic or carcinogenic air pollutant.

REFERENCES

South Coast Air Quality Management District. 1982. <u>Final Air Quality Management Plan</u>. Appendix VII-A, Measure F-2. El Monte, California. October 1982.

SCAQMD. 1986. "Recommendation of Small Business Committee to Set a Public Hearing to Rescind Rule 1102.1 - Perchloroethylene Dry Cleaning Systems". Letter to the Board of District. April 28, 1986.

SCAQMD. 1987. <u>Proposed Amended Rule 1102.1 - Perchloroethylene Dry Cleaning Systems</u>. Staff Report. Rule Development Division, El Monte, California. February 27, 1987.

FURTHER EMISSION REDUCTIONS FROM PETROLEUM SOLVENT DRY CLEANING OPERATION [ROG]

<u>SUMMARY</u>

Source Category: Petroleum Dry Cleaning

Control Methods: Operating Requirements; Eliminating Exemptions

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 0.7 | 1.0 | 1.2 |
| ROG Reduction | | 0.5 | 0.6 |

Control Cost: \$2,000 Per Ton of ROG

Other Impacts: Increased Emissions and Exposure to Potentially Toxic

Air Contaminants

DESCRIPTION OF SOURCE CATEGORY

Background

There are approximately 20 petroleum solvent dry cleaning facilities in the District. Petroleum solvent dry cleaning plants tend to be larger facilities which serve business, industrial, or institutional consumers. There are, however, some smaller commercial plants. Most plants are remotely located due to the fact that the solvent is flammable; therefore, fire regulations restrict their locations.

The dry cleaning process involves three principal steps similar to those of ordinary laundering in water: one or more washes in solvent; extraction of excess solvent by spinning; and drying by tumbling in an air stream. Emissions of solvent vapors can occur during wash, spin, or dry cycles, as well as during transferring operations—when garments laden with solvent are exposed to the atmosphere while being transferred from the washer to the dryer, or from the dryer to storage.

Regulatory History

Emissions from petroleum solvent dry cleaners are currently regulated under Rule 1102. This rule requires that trap doors be kept closed, still residues stored in sealed containers, and used filter material be placed in closed containers. The rule also requires that facilities using more than 2,642 gallons per year of petroleum solvent must vent all exhausts from cleaning equipment through a carbon adsorber or other control device of similar control efficiency.

Control measure G4 of the final 1982 AQMP revision proposed to lower the exemption limit in Rule 1102 and was formally considered by the District Governing Board at its April 1984 meeting. The Board, however, did not approve amending Rule 1102 in accordance with G4, because of concerns regarding adverse economic impacts and low emission reduction potential. Additional controls for petroleum dry cleaners are reproposed herein as part of the ozone attainment strategy.

PROPOSED METHOD OF CONTROL

Lowering of the exemption limit to plants using less than 760 gallons per year is reproposed herein. This would require some additional dry cleaners to use carbon adsorption systems or solvent recovery systems which consist of a water cooled condenser followed by solvent/water separation. Condensation systems have approximately the same control efficiency as carbon adsorption and are simpler to maintain. This requirement could also be expanded to require that all petroleum solvent dry cleaners be subject to all requirements of the rule.

In older dry cleaning systems with separate washer and extractor units, fugitive solvent emissions volatilize from clothing during transfer between these units. These emissions can be controlled by one of two ways: requiring that carts or containers used in transferring articles allow the solvent to drain into closed containers for recycling; or requiring the use of newer combination systems which contain the washer and extractor in one unit. The proposal of requiring draining of solvent into closed containers requires further study.

In addition, fugitive solvent emissions can be further reduced by establishing a maximum allowable time that articles may be left in the open prior to being placed in the dryer. Staff is considering specifying a time limit of 5 minutes or less. It is not clear yet how such a time limit could be enforced; further study is required.

EMISSIONS REDUCTION

The 1985 ROG emissions from petroleum dry cleaners are estimated at 0.7 tons per day. Emission estimates for 2000 and 2010 are 1.0 and 1.2 tons per day, respectively. Installation of a device operating at 90 percent

control efficiency would reduce overall emissions at a plant by 50 percent. Deleting the exemption in Rule 1102 would subject an additional 3 percent of the emissions. Therefore, the proposed control measure would reduce emissions from petroleum solvent dry cleaning operations by 0.5 tons per day in the year 2000 and 0.6 tons per day in the year 2010.

COST-EFFECTIVENESS

The typical cost of installing a petroleum recovery dryer unit is \$16,000. The annual operating costs are assumed to be the same as existing dryers. Assuming 50 percent recovery of the solvent, annual credits associated with the new dryer are \$380. The control cost, thus, becomes \$2,000 per ton of ROG reduced.

OTHER IMPACTS

Because of fire regulations, new petroleum dry cleaning plants cannot be established in commercial areas such as shopping centers or near residences. Those that are still operating are doing so under "grandfather" provisions and any changes in ownership or equipment would trigger action with respect to those regulations. Industry sources believe that the remaining commercial petroleum plants will either go out of business or convert to perchloroethylene regardless of District efforts on tightening Rule 1102.

Implementation of this measure will also likely increase emissions of potentially toxic solvents.

REFERENCES

U.S.Environmental Protection Agency, Region IX. 1986. <u>Reasonable Extra Efforts Program Post-1987 Area Rule Evaluation; Category: Petroleum Dry Cleaners.</u>

CONTROL OF EMISSIONS FROM UNDERARM PRODUCTS [ROG]

Summary

Source Category: Domestic Products

Control Methods: Reformulation; Alternative Application Methods;

Ban on Aerosol Products

Emissions: Not Determined

Control Cost: \$400 Per Ton of ROG

Other Impacts: Possible Increased Emissions of Air Toxics;

Unsuccessful Formulators May Be Forced from the

DESCRIPTION OF SOURCE CATEGORY

Background

Underarm antiperspirants and deodorants contribute substantially to the ROG emissions in the South Coast Air Basin. These products are available in several different forms and are ranked by market share as stick solids (41 percent), roll-ons (29 percent), aerosol sprays (25 percent), and collectively, pumps, pads, creams and squeeze bottles (5 percent) (CARB, 1987). Varying levels of photochemically reactive organic compounds (PROCs) which contribute to the formation of oxidants as well as photochemically generated particulates, are contained in underarm products. The PROC's in underarm products can be classified as: 1) propellant PROCs which are used to propel aerosol products, and 2) solvent PROCs which are part of the product formulation and may be used to solubilize the product, hasten the evaporation rate or act as an antimicrobial agent, and 3) other miscellaneous PROCs which may serve as emolients or moisturizing agents.

Regulatory History

Underarm products are not currently subject to air pollution control requirements. However, the use of chlorofluorocarbons in aerosol sprays has been banned since 1978 due to their suspected role in stratospheric ozone depletion. In addition, Measure C2 of the 1982 AQMP Revision proposed a ban on the use of aerosol sprays in the South Coast Air Basin.

In May 1984, the Board approved staffs' recommendation to move the measure to further study pending control development by the Air Resources Board (ARB). In 1987, the ARB issued a technical report which provided the local air pollution control districts with information and guidelines on the possible control options (CARB, 1987).

PROPOSED METHOD OF CONTROL

The proposed control measures are directed to control the ROG emissions from underarm products sold in the South Coast Air Basin and can result in an emission reduction in this product category by up to 50 percent.

Reformulation

Reactive organic gas (ROG) emissions from underarm products may be successfully reduced by requiring reformulation of the products with less reactive components and/or the use of less polluting mechanisms to propel the products. Reformulation options for underarm products are currently under development by the ARB. On the basis of the ARB's study, the District proposes to reduce ROG emissions through the implementation of one of the following control options: (1) limiting the vapor pressure of PROCs contained in underarm products to 80mm Hg at 20°C ; (2) limiting the relative evaporation rate of PROCs that could be used to 25 at 20°C ; (3) setting a limitation on the basis of PROC weight percent and vapor pressure; and (4) limiting the weight percent of PROCs in the product from 40 to 80 percent by weight (CARB, 1987).

Alternative Application

The use of alternative application methods in conjunction with reformulation efforts can act to substantially reduce ROG emissions from underarm aerosol sprays. Mechanical dispensers such as pumps, sprays and squeeze bottles, offering a higher transfer efficiency product application, or the use of alternative pressurized devices without using PROCs as propellants such as the self-generating carbon dioxide spray marketed by Enviro-Spray, could be developed to dispense underarm aerosol products. However, the use of alternative pressurized devices which use no propellant PROCs may require further reformulation for current product formulations where the propellant is a key constituent for product performance.

Banning

ROG emissions from underarm products may also be reduced by banning all reactive aerosol propellant formulations. The use of non reactive propellants or alternative dispensing mechanisms can be successfully employed.

EMISSIONS REDUCTION

The ROG emissions contributed from this source category are uncertain at this time and require further analysis. Due to data availability, emission incentives and potential reductions for this category are included in the succeeding measure CM #88-A-19

COST EFFECTIVENESS

The cost effectiveness for the proposed requirements for underarm products will be about \$400 per ton of ROG reduced (CARB, 1987).

OTHER IMPACTS

The proposed control options could lead to the successful reformulation and application of less ROG emitting underarm products. The substitution of exempt solvents for PROCs may result in the increased emission of potentially toxic compounds. Formulators unable to develop complying products may be forced from the market by competitors. Statewide implementation may be necessary to maximize the effectiveness of this control measure.

REFERENCES

California Air Resources Board. 1987. <u>A Technical Assessment Document for Reducing Photochemically Reactive Organic Compounds from Underarm Products</u>. California Air Resources Board. Sacramento, CA. May 1987.

Jones, LaWeeda. 1988. California Air Resources Board. Personal communication with David Vensel, March 1988.

CONTROL OF EMISSIONS FROM DOMESTIC PRODUCTS [ROG]

Summary

Source Category: Domestic Products (Non-Underarm)

Control Methods: Reformulation; Alternative Application Methods;

Ban on Aerosol Products

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 93.7 | 117.0 | 128.6 |
| ROG Reduction | | 40.9 | 45.0 |

Control Cost: Not Determined

Other Impacts: Possible Increased Emission of Air Toxics;

Unsuccessful Formulators May Be Forced from the

DESCRIPTION OF SOURCE CATEGORY

Background

A wide variety of products used in households, institutions, and commercial establishments contain organic compounds which when released into the atmosphere can react to form ozone and other photochemically reactive pollutants. Products such as paints, insecticides, cleaning solutions, and automotive and personal care products contain and release reactive organic gases during use and disposal. The photochemically reactive organic compounds in these products serve as either part of the formulation of the product itself such as in solvent cleansers or to propel the product such as in aerosol spray products. The emissions from these products represent one of the largest sources of ROG emissions in the South Coast Air Basin. Emissions from these products are projected to increase substantially over the next 20 years as the region's population increases.

Regulatory History

Domestic products with the exception of the rules governing the ROG content of architectural coatings and the ban on chlorofluorocarbons in aerosol sprays, are not currently regulated by the District. However, Measure C2 of the 1982 Air Quality Management Plan Revision proposed a ban on the use of aerosol sprays in the South Coast Air Basin. In May 1984, the Board approved staffs' recommendation to move the measure to further study pending control development by the Air Resources Board (ARB). The ARB has identified the types of products which are responsible for the majority of the ROG emissions from domestic products and has been investigating control methods and developing control guidelines for the product categories. These guidelines will provide the local air pollution control districts with information on the possible control options.

PROPOSED METHOD OF CONTROL

Reformulation

Reactive organic gas (ROG) emissions may be successfully reduced by requiring reformulation of the products with less reactive components and/or the use of less polluting mechanisms to propel the products. Several control proposals for domestic products are currently under development by the ARB. On the basis of the ARB study, the District proposes to implement one or more of the following control options: (1) limiting the vapor pressure of photochemically reactive organic compounds (PROC's) contained in the products; (2) limiting the relative evaporation rates of PROC's used; and (3) setting a limitation on the basis of PROC weight percent and vapor pressure (CARB, 1987).

Alternative Application

The use of alternative application methods can also act to reduce ROG emissions from domestic products. Mechanical dispensers such as pump sprays and squeeze bottles or the use of alternative pressurized devices which contain no propellant PROCs such as the self-generating carbon dioxide spray marketed by Enviro-Spray could be developed to dispense spray products (CARB, 1987). The implementation of a statewide control program would be most effective since a wider marketing area would provide greater incentive for product development.

Banning

ROG emissions from domestic products may also be reduced by banning all reactive aerosol propellant formulations. Reactive aerosol propellants comprised about 16 percent of ROG emissions from domestic products in 1985. The elimination of reactive aerosol propellants can result in significant emission reductions.

EMISSIONS REDUCTION

Emissions from domestic products, including consumer underarm products (CM#88-A-18), consumer aerosol propellants and aerosol and nonaerosol consumer product solvent use in the South Coast Air Basin are estimated to contribute 93.7 tons per day of ROG in 1985. Projections for the years 2000 and 2010 show ROG emissions of 117.0 tons per day and 128.6 tons per day, respectively.

The proposed control measure in conjunction with CM #88-A-18 would reduce ROG emissions in the South Coast Air Basin by about 35 percent or as much as 40.9 tons per day in the year 2000 and 45.0 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed control measure could result in product formulators incurring some expenses for refitting, such as for aerosol filling with water, exempt solvent or low reactivity based products. Water based aerosols may increase in consumer price as the manufacture would now be required to use interior lined cans to prevent corrosion. Many of the incurred compliance costs would probably be offset by being passed on to the consumer. The cost effectiveness of this measure involves numerous products and requires further analysis.

OTHER IMPACTS

The proposed control approach could lead to the successful reformulation of many ROG emitting domestic products. The substitution of exempt solvents for PROCs may result in the increased emission of potentially toxic compounds. Formulators who could not develop complying products may be forced from the market in that product area by successful competitors. Statewide implementation may be necessary to maximize control effectiveness.

REFERENCES

California Air Resources Board. 1987. <u>A Technical Assessment Document for Reducing Photochemically Reactive Organic Compounds from Underarm Products</u>. California Air Resources Board. Sacramento, CA. May 1987.

Jones, LaWeeda. 1988. California Air Resources Board. Personal Communication with David Vensel, March 1988.

CONTROL OF EMISSIONS FROM SOLVENT WASTE [ROG]

<u>SUMMARY</u>

Source Category: Solvent Wastes

Control Methods: Prohibiting Improper Disposal of Solvent Wastes;

Waste Minimization; Outreach Program

Emissions: Not Determined

Control Cost: Not Determined

Other Impacts: Decreased Emissions of Toxic Air Contaminants;

Increased District Enforcement and Administrative

Activities

DESCRIPTION OF SOURCE CATEGORY

Background

Approximately 500,000 tons of solvent-borne wastes are generated annually in the Basin from a myriad of diverse industrial and commercial operations including degreasing, coating application, printing, chemical formulation, and solvent reclamation (SCHWP, 1985). This waste is generally in the form of aqueous liquids, sludges, or still bottoms. At present, these wastes are recycled on-site or by reclamation facilities offsite, disposed of through the public sewer system, and/or disposed of in Class I landfill sites. The handling and disposal of solvent wastes can contribute emissions of ROG as the solvent volatilizes from the waste into the atmosphere.

This control measure is intended to reduce emissions of reactive organic gases (ROG) from solvent wastes and to prevent further emissions which may occur as a result of landfill restrictions of these wastes. This measure is intended to support current land disposal restrictions of solvent wastes, while ensuring that the implementation of such restrictions do not result in needless emissions to the atmosphere. This measure is directed at industrial and commercial waste generation. Domestic use of solvents is addressed in the measure titled "Control of Emissions from Underarm Products" and "Control of Emissions from Domestic Products."

Regulatory History

District Rule 442 currently prohibits anyone, during any one day, from disposing of more than 5 liters (1.3 gallons) of any photochemically reactive solvent or solvent containing material, by any means which will permit the evaporation of such solvent into the atmosphere. Several other District rules restrict solvent disposal in specific operations. These rules prohibit the disposal of solvent in such a manner which may allow it to volatilize into the atmosphere.

The 1984 amendments to the Resource Conservation and Recovery Act bans the land disposal of solvent wastes beginning in November 1986. The California Department of Health Services (DOHS) has also implemented a program to restrict land disposal of various types of solvents and other hazardous wastes. Land disposal will be strictly prohibited unless DOHS and EPA determine that: 1) there are land disposal options which do not threaten human health and the environment; or 2) there are waste treatment options which will alter the waste and thereby minimize the risk of its land disposal. Several categories of hazardous wastes are to be banned from land disposal (See Table 1), many of which contain reactive solvents. To meet these requirements, small and large generators will undertake efforts to minimize waste generation which could result in further ROG emissions to the atmosphere.

PROPOSED METHOD OF CONTROL

The control approach of this measure is two fold: it is directed at reducing existing emissions from solvent wastes and preventing future emissions which may occur as a result of landfill restrictions of these wastes. This measure proposes: 1) to prohibit any industrial commercial operation from disposing of solvent in such a manner as to permit it to evaporate into the atmosphere; 2) to require waste reduction as the option for waste generators; and 3) to establish an outreach program for small and large solvent waste generators.

Reduction of Evaporative Solvent Emissions

This measure proposes to prohibit all operations from disposing of solvent in such a manner which may allow it to evaporate into the atmosphere. This would involve either amending Rule 442 to eliminate the 5 liters per day requirement or placing such a restrictive requirement in each individual rule which pertains to an operation in which solvent is used. Generators would need to contract with reclamation facilities, or change their process to eliminate or reduce solvent usage.

Reduction of Solvent Wastes

In order to comply with ongoing DOHS/EPA land disposal restrictions, small and large generators will need to select among four principal options: 1) destructive treatment, including thermal oxidation; 2) removal of toxic or

flammable constituents prior to land disposal; 3) recycle/reuse including use as a fuel substitute; and 4) reduction or elimination of waste generated (Blaney,1986). The fourth option is one which is being pursued by many generators, since it is often preferable to the increasing costs of waste management. It is this fourth option which is also most promising from the standpoint of reducing the overall emissions of solvent vapors.

Outreach Program

An outreach program for small and large generators of solvent wastes could disseminate information on waste reduction alternatives. This outreach program could be established and directed by the District and/or DOHS.

Such efforts are already underway. DOHS presented educational symposia on solvent waste management alternatives to land disposal, during October of 1986. The symposia provided information to encourage and assist industries with improving their management of solvent wastes. The goal of the symposia was to identify effective alternative technology that could lead to either reduction in the amount of solvent waste generated or increased recycling potential of the solvent waste that is generated. In addition, DOHS is conducting waste management audits for various industries to facilitate the use of waste minimization techniques.

EMISSIONS REDUCTION

Potential ROG emissions from the handling, recycling, and indiscriminate disposal of solvent wastes can range from 20 to 40 tons per day. However, an accurate estimate of ROG emissions from these activities is, at present, unknown and requires further analysis. It is also difficult at this time to determine the extent of increase in ROG emissions which could take place from the implementation of landfill restrictions. An estimate of the emissions reduction from this measure is, therefore, unknown at this time.

COST EFFECTIVENESS

Implementation of proposed control requirements may increase handling costs for small quantity generators of solvent wastes. The cost effectiveness associated with this measure is unknown at this time and require further analysis.

OTHER IMPACTS

Since many solvents are toxic, this measure will help to reduce toxic air contaminants from public treatment works and other sources where spent solvents are disposed of and allowed to volatilize into the atmosphere. This measure may increase District enforcement and administrative activities.

REFERENCES

Southern California Hazardous Waste Project. 1985. <u>The Problems and Needs for the Management of Hazardous Wastes in Southern California</u>, Submitted by Louis Berger and Associates, Inc., 1985.

Blaney, B. 1986. "Alternative Techniques for Managing Solvent Wastes", Journal of Air Pollution Control Association, March 1986.

FURTHER EMISSION REDUCTIONS FROM ADHESIVES [ROG]

SUMMARY

Source Category: Adhesives

Control Methods: Low-VOC Formulations

Emisions: Not Determined

Control Cost: Not Determined

DESCRIPTION OF SOURCE CATEGORY

Background

Adhesives such as glue, mucilage, paste, rubber cement, etc., are used to hold similar and dissimilar materials (e.g., glass, plastic, rubber, wood, and metal) together. Different types of adhesives are used to bond materials together including: contact adhesives, heat-cured adhesives, hot-melt adhesives, UV-cured adhesive, and elastomeric.

Adhesives are used in various manufacturing processes such as auomotives, aircrafts, boats, and furniture manufacturing, and come in two forms: solid and liquid. Solid adhesives are made in blocks or sheets and are applied by melting the blocks or by layering the substrates over and under the sheet adhesives. Liquid adhesives are either water-borne, solvent-borne or solventless. Liquid adhesives may be applied by brushing, dipping, flow-coating, roller-coating, or spraying.

Solvent-borne adhesives are the main source of VOC emissions in this source category. Solvents are the media for transferring the adhesive materials to the substrates, and must be capable of dissolving all of the various adhesive components. Criteria requirements for the solvent are the ability to wet the substrate which promotes adhesion and to have a viscosity which allows uniform application of the adhesive.

Regulatory History

Rule 1145, Plastic, Rubber, and Glass Coatings and Adhesives, regulates the VOC content of adhesives applied to plastic, rubber, and glass. The rule was adopted on July 8, 1983 and set the VOC limit for adhesives at 250 gm/1 with the exemption given to elastomeric adhesive (any adhesive containing natural or synthetic rubber). Two other District rules regulate the VOC content of adhesives or pre-bonding materials. Rule 1104 sets the VOC limit for adhesives used in making flat woodstock at 250gm/1, and Rule 1124 sets the VOC limits of pre-bonding materials (adhesive-bonding primer) used in aerospace industries at 850 gm/1.

Although emissions from adhesives have been regulated by the solvents and coatings rules and regulations, it was decided to regulate emissions from adhesives separetely and Rule 1168 was proposed as part of the 1982 AQMP Revision process. The proposed Rule 1168, VOC Content of Adhesives, currently under development, will regulate emissions from adhesives used in various manufacturing processes.

PROPOSED METHOD OF CONTROL

To control VOC emissions form adhesives, a general VOC limit of 250 gm/l is proposed; however, appropriate limits for adhesives applied in special processes such as structral adhesives, multipurpose adhesives, tire adhesives, etc. are being developed.

Primary control method proposed for this measure is reformulation technology (add on control devices such as afterburners and carbon adsorbers could also be applied to reduce VOC emissions below the proposed limits, if reformulation is not feasible). Low-VOC formulations of waterbased, exempt solvent-based, hot-melt (solventless), high solid, and polymerizing adhesives are required to replace high-VOC adhesives:

High-Solid Adhesives

High-solid adhesives have a high solid to solvent ratio. This reduces VOC emission by applying the same amount of solid with less VOC. The disadvantage of these adhesives is that they may be too thick to apply in a uniform layer.

Water-borne Adhesive

Water-borne adhesives use water to replace part or all of the solvent. The emission reduction potential depends on the extent of the solvent replacement. Water-borne adhesives may dry slower than solvent-borne adhesives and therefore, slow down production.

Exempt Solvent Formulations

Exempt solvent formulations replace the VOC solvents with halogenated hydrocarbons (such as freens, 1,1,1-trichloroethane). Since these materials do not produce smog in the atmosphere, they are a good substitute for VOC. Contrary to water-borne adhesives, they tend to dry fast. Halogenated solvents have the disadvantage of tendency to react with metal substrate and equipment, causing corrosion.

Hot-Melt Adhesives (solventless)

Hot-melt adhesives have no solvent and therefore produce no VOC emissions. However, they setup fast and are not flexible and may require modification of manufacturing process.

Polymerizing Adhesives

Polymerizing adhesives are liquid at application and become solid when cured and contain no VOC. These adhesives may require the installation of an "UV" lamp or the introduction of a chemical free radical initator to initate the polymerization reaction. These materials have better penetration than the hot-melt adhesives, but are not very flexible either.

EMISSIONS REDUCTION

VOCs from the use of adhesives are mainly emitted from the evaporation of solvents during the application of adhesives. Little or no VOC is emitted during the curing process. Since only a small part of the emissions from this source was regulated by Rules 1145, 1104, or 1124, about 50 percent of the emissions from this source is anticipated to be reduced by this proposed control measure. The emissions inventory for this source category has not been determined and require additional analysis.

COST EFFECTIVENESS

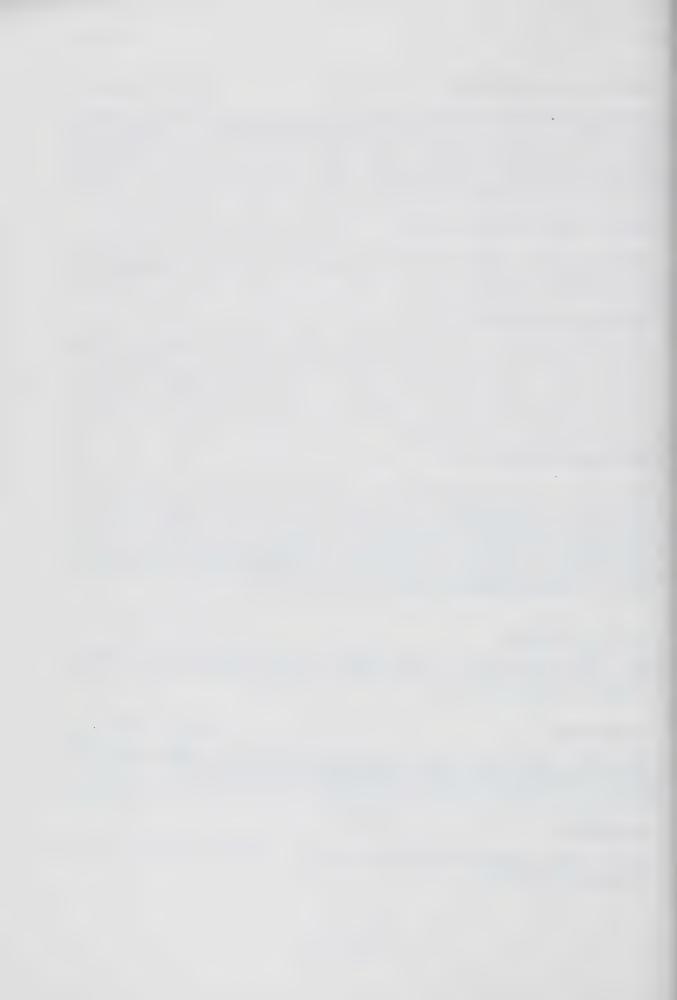
The cost effectiveness of implementation of the proposed control measure is uncertain at this time and requires further analyses.

OTHER IMPACTS

There are some concerns over potential toxicity of 1,1,1-trichloroethane used as exempt solvent in the adhesives reformulation.

REFERENCES

Price, Monty. 1988. AQMD Rule Division. Personal communication with S.Cohanim, May 1988.



B- PETROLEUM AND GAS PRODUCTION

Petroleum and gas production sources contributing to the emissions in the Basin are listed in Table I-2B. Detailed description of proposed control measures for each of these source categories are discussed in the following section.

TABLE I-2B TIER I CONTROL MEASURESPETROLEUM AND GAS PRODUCTION

| | CONTRO No. | TITLE |
|-------------|---------------|--|
| B-1 | | Control of Emissions from Gasoline Transfer: Fail Safe Phase-I Vapor Recovery Systems, [ROG] |
| B-2 | | Control of Emissions from Gasoline Transfer: Improved Installation and Repair of Phase-II Vapor Recovery Systems, [ROG] |
| B-3 | | Control of Emissions from Open Sumps, Pits, and Wastewater Separators, [ROG] |
| B- 4 | | Control of Emissions from Pleasure Boat Fueling Operations, [ROG] |
| B-5 | | Control of Emissions from Cyclic Steam Production Wells, [ROG] |
| B-6 | | Control of Emissions from Crude Oil Pipeline Heaters, $[NO_X]$ |
| B-7 | | Control of Emissions from Petroleum Refinery Fluid Catalytic Cracking (FCC) Units, [SO _X] |
| B-8 | | Control of Emissions from Petroleum Coke Calcining Operations, $[SO_X]$ |
| B-9 | | Control of Emissions from Gas Fired Petroleum Refinery Process Heaters, [PM] |
| B-10 | | Improved Control of Emissions from Petroleum Refinery Fluid Catalytic Cracking (FCC) Units, [PM] |
| B-11 | | Control of Emissions From OCS Exploration, Development, and Production, [All Pollutants] |
| B-12 | | Control of Emissions From Petroleum Refinery Flares, [All Pollutants] |
| B-13* | | Further Emission Reductions from Valves, Pumps, and Compressors Used in Oil and Gas Production Fields, Refineries and Chemical Plants, [ROG] |

TABLE I-2B TIER I CONTROL MEASURESPETROLEUM AND GAS PRODUCTION (continued)

| AQMP CONTRO | TITLE |
|-------------|--|
| B-14 | Control of Emissions from Oil Field Steam Generators, $[NO_X]$ |
| B-15* | Control of Emissions from Petroleum Refinery Heaters and Boilers, $[{\rm NO}_{\rm X}]$ |

CONTROL OF EMISSIONS FROM GASOLINE TRANSFER FAIL-SAFE PHASE-I VAPOR RECOVERY SYSTEMS [ROG]

<u>SUMMARY</u>

Source Category: Gasoline Transfer

Control Methods: Fail-Safe Phase-I Vapor Recovery

Systems

Emissions:

(Tons/Day) Year 1985 Year 2000 Year 2010

ROG Inventory 3.7 4.0 4.1

ROG Reduction --- Not Determined

Control Cost: Not Determined

Other Impacts: Reduced Exposure to Toxic Air Contaminants;

CARB Certification Required; Fuel Savings;

Decreased Odor Nuisance

DESCRIPTION OF SOURCE CATEGORY

Background

Motor vehicles use over 9 million gallons of gasoline each day in the South Coast Air Basin. There are approximately 8,000 service stations and 5,000 non-retail facilities which dispense the gasoline fuel. These facilities receive their gasoline supply by tank trucks. The Phase I vapor recovery systems route the gasoline vapors displaced from the stationary storage tank by the incoming fuel to the delivery truck. The delivery truck stores the vapors in its on-board tank and later transfers the vapors to the terminal or bulk plant for processing into liquid fuel or disposal by an acceptable emission control technique.

There are two types of Phase I systems: the dual and the coaxial. For dual systems, the fuel delivery and vapor recovery hoses are connected to two separate access points on the storage tank. The fuel is delivered by gravity to the submerged fill pipe and the displaced vapors recovered through a second opening at the top of the storage tank. The vacuum which

is created in the delivery truck's on-board tank causes the displaced vapors to flow into the truck. The inflowing gasoline displaces a nearly equal volume of partially saturated gasoline vapors.

Coaxial systems operate by the same principle, but accomplish gasoline delivery and vapor recovery through a single access point. The fuel delivery and vapor recovery hoses are attached by a special two hose adapter to a single coaxial fill pipe. The coaxial fill pipe is composed of a tube within a tube. Gasoline flows into the storage tank through the submerged inner tube and displaced vapor flows out of the tank through the space between the walls of the inner tube and the outer tube.

Phase I systems have been utilized for more than 10 years in the South Coast Air Basin to reduce ROG emissions. These systems reduce vapor filling losses by at least 96 percent when operating at design efficiency. System performance in practice may be significantly less than the design efficiency because of human errors in operating the system.

For a Phase I system to achieve its design efficiency, the following criteria must be met:

- (1) the vapor return line must be connected during the fuel transfer;
- (2) there must not be any significant leaks in the system;
- (3) the vapor return line and connectors must be of sufficient size and free of restrictions to allow unimpeded vapor flow to the delivery truck; and
- (4) fuel entry into the storage tank should occur below the gasoline surface in the tank through a submerged fill pipe.

Good operating practices and procedures can be inconvenient and in some instances may have a negative cost impact, since such practices and procedures require that more time be spent in the overall transfer of fuel. Monitoring efforts have shown that some individuals intentionally deliver gasoline without properly connecting the recovery system or utilize systems which are in disrepair. This improper use of equipment or mal-maintenance occurs more frequently with independent haulers. Phase I systems can be redesigned to mitigate these problems and reduce excess ROG emissions from improper practices and procedures.

Regulatory History

District Rule 461 requires the use of a Phase-I vapor recovery system during fuel transfer from the delivery trucks to the facility. Items 1, 2 and 3 of the above are required under Rule 461, but compliance depends on good operating practices and procedures. Item 4 is a design requirement contained in Rule 461. The proposed control measure is directed toward the emission control of ROG from Phase I fuel transfer system, due to improper practices and procedures.

PROPOSED METHOD OF CONTROL

This control measure proposes to require the use of fail-safe equipment in all Phase-I fuel transfer systems. Under this measure, existing designs will be modified for reliable, automatic shutdown of gasoline flow at any time the system is not functioning properly. Shutdown will occur when the system is not properly connected, flow is obstructed, or a significant vapor leak occurs. Fail-safe systems will include sensors, actuators, pneumatically operated valves, and an integrated circuit control module. The sensors will function to detect proper coupling of the transfer lines and proportional flows for delivered gasoline and received vapors. The actuators will rapidly close the pneumatically operated valves upon receiving a signal from the control module that the system is malfunctioning.

A fail-safe system designed especially for Phase-I vapor recovery is not at the present time commercially available, but similar systems have been designed for fail-safe transfer of hazardous fluids utilizing off-the-shelf components. Therefore, fail-safe Phase-I systems appear feasible over the next 5 to 7 years. Criteria for system design and component selection should be reliability, compatibility with gasoline and its vapors, off-the-shelf availability, cost, and weight.

Once fail-safe systems are available for service station applications, actions should be taken to transfer the technology to vapor recovery systems for other sources.

EMISSIONS REDUCTION

During 1985, ROG emissions from transferring gasoline to service stations was about 3.7 tons per day. In the years 2000 and 2010, emissions are projected to reach about 4.0 and 4.1 tons per day, respectively. An unknown amount of these emissions are due to improper functioning of Phase I systems.

About 0.4 lbs of ROG are emitted per 1,000 gallons of gasoline transferred with a properly functioning Phase-I system. Without a properly functioning Phase-I system, the emission rate can be as high as 8.8 lbs of ROG per 1,000 gallons of gasoline transferred. For instance, when the vapor recovery hose is not properly connected, ROG emissions will occur up to the uncontrolled rate of 8.8 lbs per 1,000 gallons of gasoline transferred. Emissions from systems with a vapor leak will occur at a level somewhere within the range defined above depending upon the size of the leak. Determination of the overall emissions reduction associated with this measure requires better information regarding in-use investigating ways to obtain this information.

COST EFFECTIVENESS

Cost effectiveness cannot be determined until further studies are completed regarding the extent of malfunction/malpractice, possible system designs, and comparative cost analysis with similar systems developed for the transfer of hazardous liquids.

OTHER IMPACTS

Requiring fail-safe Phase-I systems is within the jurisdiction of the District, but such systems will need California Air Resources Board certification. There are a number of issues which must be addressed as this measure is further developed. These include: the ability to develop systems which are compatible with fire codes, appropriate procedures for evaluating the maintenance of these systems, and control cost effectiveness.

Implementation of fail-safe systems will provide the additional benefits of reduced populational exposure to toxic air contaminants (e.g., benzene), fuel savings (i.e., from recycled gasoline vapors), and decreased odor nuisance from excessive vapor discharge to the atmosphere. There are no potential adverse environmental or administrative impacts associated with the proposed measure.

REFERENCES

Houghton and Simmons. 1984. <u>Fail-Safe Transfer Line for Hazardous Fluids</u>, EPA Project Summary, EPA-600/S2-83-099. February 1984.

South Coast Air Quality Management District. 1986. <u>Gasoline Transfer and Dispensing Vapor Recovery Inspection Guide</u>.

South Coast Air Quality Management District. "Rule 461". Adopted January 9, 1976; Amended November 1, 1985.

U.S. Environmental Protection Agency. 1984. <u>Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry</u>. EPA-450/3-84-012a.

CONTROL OF EMISSIONS FROM GASOLINE TRANSFER IMPROVED INSTALLATION AND REPAIR OF PHASE-II VAPOR RECOVERY SYSTEMS [ROG]

SUMMARY

Source Category: Gasoline Transfer

Control Methods: Licensing of Emission Control Contractors

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 3.9 | 4.2 | 4.3 |
| ROG Reduction | | 0.4 | 0.4 |

Control Cost: \$110 Per Ton of ROG

Other Impacts: Reduced Toxic Exposure; Fuel Savings; Reduction in

Violation-Notices and Caseloads

DESCRIPTION OF SOURCE CATEGORY

Background

There are approximately 8,000 retail and 5,000 private-use gasoline dispensing facilities with about 95,000 nozzles in the South Coast Air Retail gasoline dispensing facilities average about 10 to 12 nozzles each, while private-use (consumer) facilities average about 1.5 nozzles each. The Phase-II vapor recovery systems collect the gasoline vapors which are displaced from the vehicle fuel tank during refueling. The captured vapors are recycled to the facility's gasoline storage tank reducing ROG emissions which would otherwise escape to the atmosphere.

There are currently five manufacturers in the Basin which have received certification of their equipment from California Air Resource Board by meeting the 95 percent vapor capture efficiency: Healy (Cambridge Engineering Inc.), Emco Wheaton, Hasstech Inc., Hirt Combustion Engineers, and OPW-Dover Corp. Two companies are certified to remanufacture such used equipment: EZ-Flow and Rainbow. In addition, there are about 50 companies in the District which are not required to be certified, but are installing and maintaining such equipment. However, the equipment is complex enough so that improper installation and maintenance constitute an estimated 15 percent of the violation notices issued.

Phase-II systems do not achieve the 95 percent capture level in consumer use unless they are properly installed and maintained. To provide an incentive for the proper installation and maintenance of these systems, the District monitors facilities with these systems as part of its rule enforcement program.

Regulatory History

Rule 461 requires that all gasoline dispensing facilities equip their pumps with Phase-II vapor recovery systems. Rule 461 also requires that Phase-II systems used in the South Coast Air Basin be certified by the California Air Resources Board.

The proposed control measure herein is directed toward the emission control of ROG from Phase-II vapor recovery systems. A two-part control measure for improving the installation and repair of Phase-II vapor recovery systems was originally proposed: (1) a licensing program for installation and maintenance companies; and (2) an outreach program to provide optional training courses. However, in the latter part of 1987 the Office of Operations instituted a similar outreach program directed primarily at violators of Rule 461. This program is analogous to the DMV's Traffic School. As a result, only the licensing program is introduced here.

PROPOSED METHOD OF CONTROL

Excess ROG emissions from improper installation and maintenance of Phase-II equipment should be further reduced through a measure designed to improve the training of individuals who install and repair this equipment. The District should license individuals/companies who are in the business of installing/repairing Phase-II equipment. Rule 461 could be amended to require that persons who are in the business of installing and repairing Phase-II equipment, successfully complete a training course approved or given by the District. License renewal could be based on service record as determined through the District's service station inspection program. The licensing procedure envisioned is analogous to the required licensing of mechanics who offer biennial Motor Vehicle Inspection and Maintenance testing.

EMISSIONS REDUCTION

During 1985, ROG emissions from gasoline fueling of motor vehicles was about 3.9 tons per day. In the years 2000 and 2010, emissions are projected to reach about 4.2 and 4.3 tons per day, respectively.

Gasoline dispensing facilities with properly functioning Phase-II systems emit about 0.5 lbs of ROG per 1,000 gallons of throughput. The comparable emission factor for facilities without Phase-II systems is about 10 lbs per 1,000 gallons of throughput. Phase-II nozzles which are improperly installed or repaired, and are malfunctioning, are estimated to average an emission rate of about 5 lbs per 1,000 gallons of throughput. If implementation of the proposed actions decreases the current malfunction rate from improper installation and repair by 80 percent, approximately a 0.4 tons per day reduction in excess ROG emissions will occur. This amounts to about a 9 percent emission control.

COST EFFECTIVENESS

The control cost for this measure is estimated at \$110 per ton of ROG reduced. This is based on the assumption of 200 licensees in the Basin, and training courses taken once every three years.

OTHER IMPACTS

There would be about a 12 percent reduction in Service Station violation-notices and legal proceedings. The proposed measure is feasible and within the jurisdiction of the District. No significant cost impact is projected for businesses which install or repair Phase II equipment for service station owners.

The reduction in violations will provide the additional benefits of reduced populational exposure to toxic gasoline vapors (e.g., benzene), and fuel savings (i.e., from recycled gasoline vapors). There are no potential adverse environmental impacts associated with the proposed measure.

REFERENCES

South Coast Air Quality Management District. 1986. <u>Gasoline Transfer and Dispensing Vapor Recovery Inspection Guide.</u>

South Coast Air Quality Management District. "Rule 461". Adopted January 9, 1976; Amended November 1, 1985.

U.S. Environmental Protection Agency. 1984. <u>Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry</u>, EPA-450/3-84-012a.

CONTROL OF EMISSIONS FROM OPEN SUMPS, PITS, AND WASTEWATER SEPARATORS [ROG]

SUMMARY

Source Category: Petroleum Sumps, Pits, and Wastewater Separators

Control Methods: Covers; Replacement With Enclosed Tanks

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 2.3 | 2.4 | 2.5 2.4 |

Control Cost: \$2,900 Per Ton of ROG

Other Impacts: Decreased Soil and Groundwater Contamination

DESCRIPTION OF SOURCE CATEGORY

Background

Refinery and oil production field operations employ some kind of treatment to upgrade the quality of their effluent in order to be able to send the wastewater to the sewer or to reuse it. Part of this wastewater treatment is oil-water separation which involves the separation and recovery of valuable oil. Uncovered separators are a source of fugitive ROG emissions during the treatment process.

In addition to wastewater separators, open excavated depressions in the ground are used in oil production fields for partial separation of oil, water, and sand and for temporary storage of waste products. These excavated depressions are commonly termed "sumps" or "pits." There are over 150 such sumps or pits in the South Coast Air Basin and at least 70 percent of them are open to the atmosphere.

Although the use of sumps and pits is commonplace in California oil fields, they are rarely used in other parts of the U.S. (e.g., Texas and Kansas). In these places closed tanks have been substituted in their place. The primary reasons for phasing out open sumps and pits have been to: improve

operational efficiency by decreasing fugitive emissions, reduce ground water contamination, and decrease offensive odors.

Regulatory History

District Rule 464 requires the use of covers on wastewater separators and their forebays to reduce fugitive ROG emissions. It exempts, however, three categories of separators: 1) small separators used in refineries, 2) separators used in oil production fields, and 3) coal tar wastewater separators. Control measure A5 in the 1982 AQMP proposed the elimination of the exemptions for separators used in oil production fields and refineries. Subsequent to its adoption as part of the 1982 AQMP, control measure A5 was redesignated as needing further study because of its low emission reduction potential.

The control measure proposed herein reintroduces the concept of eliminating (or further limiting) the existing exemptions in Rule 464. In addition, this measure also proposes expanding Rule 464 to explicitly include all oil field sumps and pits. EPA Region IX has also recommended eliminating or further limiting the existing exemptions in Rule 464 under the Reasonable Extra Efforts Program.

PROPOSED METHOD OF CONTROL

Implementation of this measure will require facility operators to replace their open sumps, pits or exempt separators with closed tanks or install solid covers over their existing units. The tank and cover technologies that will be required are well known and widely used in the petrochemical refining and organic chemical manufacturing sectors. Transfer of these technologies is expected to be relatively easy, since many of the operators own other facilities where these emission control techniques are already being used.

EMISSIONS REDUCTION

During 1985, exempt separators, open sumps, and open pits emitted about 2.3 tons per day of ROG. In the years 2000 and 2010 ROG emissions from this source category is expected to be 2.4 tons per day and 2.5 tons per day, respectively. It is estimated that implementation of this measure will reduce emissions from these units by 95 percent. Therefore, the emission reduction is expected to be 2.3 tons per day in the year 2000 and 2.4 tons per day in the year 2010.

COST EFFECTIVENESS

The total area of the separators to be covered is estimated about 40,000 square feet (Edgington Oil Co., et al, 1979). Assuming a capital cost of \$25 per square foot of cover (ARB, 1979) and an Operating and Maintenance

(0 & M) cost of \$2.10 per square foot (EPA, 1977), the control cost for this measure will be about \$2,900 per ton of ROG reduced.

OTHER IMPACTS

Implementation of this measure will reduce leaks to underground water supplies as well as soil contamination.

REFERENCES

California Air Resources Board. 1979. <u>Control of Organic Gas Emissions from Refinery Oil-Water Separators</u>. California Air Resources Board Staff Report, Sacramento, California. April 1979 (adjusted to 1987 dollars).

Edgington Oil Co., Golden Eagle Refining, Chevron USA, and Douglas Oil Co. 1979. Letter to South Coast Air Quality Management District. November 1979.

South Coast Air Quality Management District. 1987. "Automated Equipment Inventory System". Equipment No. 294800. August 1987.

U.S. Environmental Protection Agency Control Technology Group. 1977. Control of Refinery Vacuum Producing Systems, Waste Water Separators and Process Unit Turnarounds. October 1977.

CONTROL OF EMISSIONS FROM PLEASURE BOAT FUELING OPERATIONS [ROG]

SUMMARY

Source Category: Gasoline Fueling of Boats

Control Methods: Phase II Vapor Recovery Equipment

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 0.5 | 0.6 | 0.7 |
| ROG Reduction | | 0.6 | 0.7 |

Control Cost: \$1,200 Per Ton of ROG

Other Impacts: Decreased Spillage of Liquid Gasoline into Water;

Reduced Harmful Effect on Marine Biota *************************

DESCRIPTION OF SOURCE CATEGORY

Background

Pleasure boats are estimated to use between 2 and 34 million gallons of gasoline each year in the South Coast Air Basin. District staff believes that gasoline usage is closer to 20 million gallons. The days of peak pleasure boat usage coincide with the peak smog days of the summer months. Pleasure boat refueling stations receive their gasoline from various gasoline bulk plants via gasoline tanker trucks.

Some large-volume dealers transfer up to 800,000 gallons of gasoline per year. These dealers are primarily located along the coast where emissions will have a long residence time in the Basin's atmosphere and are likely to contribute to ozone formation.

Regulatory History

District Rule 461 requires the use of Phase I vapor recovery system during transfer of the gasoline from the delivery truck to the facility. There is

no requirement to collect the gasoline vapors displaced when the fuel is subsequently transferred to pleasure boats.

The control measure A7 in the 1982 AQMP originally proposed the installation of vapor recovery systems to control ROG emissions from refueling of gasoline powered pleasure boats and other gasoline powered craft. No implementation action has been taken or is expected to occur prior to adoption of this AQMP revision. Therefore, the control measure proposed herein reintroduces the concept.

PROPOSED METHOD OF CONTROL

This control measure recommends that vapor recovery capability be required to capture the gasoline vapors displaced from the pleasure boat tanks during refueling, thus completing the vapor recovery link from supplier to consumer. Implementing provisions would include a vacuum-assisted recovery system and an inexpensive soft rubber universal nozzle boot. The proposed controls are similar to those currently used for refueling of motor vehicles, and should achieve an emission reduction of 90 to 95 percent.

EMISSIONS REDUCTION

In 1984, District staff sent questionnaires to the gasoline suppliers in the Basin in order to determine the annual amount of gasoline used by pleasure boats. The results showed that sixteen operators pumped a total of 2,074,470 gallons of gasoline in 1980. This figure would indicate that the average boat uses only 10 gallons of gasoline in a season, an unlikely low number. One reason that this figure could be low is that the tanker trucks which link between the bulk plants and the marina gasoline storage tanks, could not be fully surveyed. The 1984 estimates by Ocean Development Department, 200 gallons per boat or 34 million gallons per year, was probably too high.

New emissions data from the District's emissions inventory group for 1985, supported by inputs from KVB, suggests some new numbers for gasoline usage in pleasure craft in lakes, rivers, and coastal areas of the Basin. The 1985 estimate for gasoline usage is approximately 19 million gallons per year. Projecting from this value to the years 2000 and 2010 yields an estimate of 24 million and 26 million gallons per year. Based on an emission factor of 19.12 pounds of ROG per 1000 gallons of gasoline used (including spillage), 0.6 tons per day of emissions will be produced in the year 2000 and 0.7 tons per day in the year 2010 from pleasure boating. As noted above, reductions of up to 90 or 95 percent would be expected using the recommended vacuum-assisted vapor recovery systems. Thus, under the 365-day year, the emission reduction for the year 2000 is 0.6 tons per day and for the year 2010 is 0.7 tons per day.

COST EFFECTIVENESS

At a given fueling station, with an annual throughput of 100,000 gallons, the control cost is about \$1,200. The estimate is based on assumptions of annual maintenance costs of \$470 and \$300 credits due to vapor recovery.

OTHER IMPACTS

An added benefit is that the incidence of gasoline spillage around marine filling stations and the harmful effect of such spillage on wildfowl and the marine biota would be minimized.

The additional energy required to operate vapor recovery vacuum-assist pumps should be adequately offset by making available the energy from gasoline formerly spilled.

REFERENCES

South Coast Air Quality Management District. 1985. <u>Proposed Rule 1144 - Marine Fuel Transfer</u>.

CONTROL OF EMISSIONS FROM CYCLIC STEAM PRODUCTION WELLS [ROG]

<u>SUMMARY</u>

Source Category: Oil Production

Control Methods: Gas Collection; Flaring

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 0.1 | 0.1 | 0.1 |
| ROG Reduction | | 0.1 | 0.1 |

Control Cost: \$3,800 Per Ton of ROG

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

When oil is first removed from the ground, there is normally enough associated gas pressure to force the oil out of the ground. When the gas pressure diminishes, the oil must be pumped out of the ground. As oil is removed from the field, the remaining oil becomes more viscous and harder to pump. As an oil field becomes depleted, secondary and tertiary techniques are used to increase well-head pressure and reduce the viscosity of the oil to increase production. Secondary enhancement techniques are the injection of water and natural gas; tertiary techniques are: injection of steam, injection of chemical (including carbon dioxide), and fire flooding.

In steam drive wells, steam is injected into a well and oil is recovered from adjacent wells. Steam and gases create pressure in the underground formation, which retards the flow of oil to the well casing. To release this pressure, gases are vented to the atmosphere through well-head vents. The well-head vent gases are condensed with air-cooled condensor. The condensate is processed as part of the field's oil production. The non-

condensable gases are combusted either on-site or processed off-site to be commercial grade natural gas.

In cyclic steam operations, steam is injected into a producing well for several days. The well is capped off and allowed to soak for an extended period. After the steam has fluidized the oil, the well is reopened and pumping operations resumed. Pumping operations continue until the oil becomes too viscous to pump, then steam is again injected into the well. The process is repeated on a regular (cyclic) basis.

Regulatory History

ROG emissions from steam-driven oil production wells are regulated by District Rule 1148. ROG emissions from wells enhanced by chemical or carbon monoxide injection, as well as those from fire flooding, are not regulated by specific rules.

A staff report on ROG emissions from cyclic steam enhanced production wells was presented to the SCAQMD Board at the May 1983 Board meeting. In that report, staff estimated that only 70 of 686 cyclic steam wells were uncontrolled. The 70 wells emitted 0.12 ton of ROG per day. It was believed the production from these 70 wells was diminishing and might soon cease, and therefore staff recommended that no rule for cyclic steam production wells be developed.

PROPOSED METHOD OF CONTROL

The most practical method of control is either to shut off the well-head vent or to vent the emissions to a gas-collection system. Combusting emissions with a flare is possible, but least likely because it is several times more expensive than the other methods.

The proposed actions will only regulate the ROG emissions from cyclic steam wells. The emissions from the production of 500,000 barrels (1985) from fire-flood operations and 700,000 barrels (1985) from caustic flooding and carbon dioxide injection are not regulated by this measure.

EMISSIONS REDUCTION

The survey of cyclic steam wells showed that there were 61 wells that were shut in, 496 wells were controlled by gas-collection systems and 70 wells uncontrolled (Table 1). With an emissions factor of 3.6 pounds per day per well, the ROG emissions are about 0.1 tons per day. Controlling these wells would reduce ROG emissions by 0.1 tons per day.

TABLE 1

CYCLIC STEAM PRODUCTION WELLS IN SCAQMD

| Company | <u>Field</u> | (1982) | Wells (1987) | Controls |
|-----------------------|--------------------|--------|-----------------|----------------|
| Shell Oil | Olinda Fee II, III | 7 | 61 | Shut In |
| Aminoil | Huntington Beach | 45 | 0 | Gas-Collection |
| Union Oil System | Brea-Olinda | 6 | 0 | Gas-Collection |
| Thums System | Wilmington | 235 | 0 | Gas-Collection |
| Sun Oil System | Wilmington | 4 | 0 | Gas-Collection |
| Champlin System | Wilmington | 1 | 10 | Gas-Collection |
| Long Beach System | Wilmington | 4 | 465 | Gas-Collection |
| Santa Fe System | Olinda | 22 | 21 | Gas-Collection |
| Tenneco Oil System | Yorba Linda | 48 | 0 | Gas-Collection |
| Mobil System | Newport Beach | 244 | 0 | Gas-Collection |
| Gulf Oil | Yorba Linda | 70 | 70 | Uncontrolled |

COST EFFECTIVENESS

The 1983 estimated cost effectiveness for a gas-collection system was \$3,600 per ton (SCAQMD, 1983). Using the Chemical Engineering Plant Cost Index, the cost, in current dollars, is \$3,800.

OTHER IMPACTS

Implementation of this measure is not expected to result in any adverse impacts.

REFERENCES

California Department of Conservation, Division of Oil and Gas. 1985. 71st Annual Report of the State Oil and Gas Supervisor.

Dangerfield, K. 1987. Personal communication with Monty Price, September 1987.

South Coast Air Quality Management District. 1983. <u>Rule 1148 - Thermally Enhanced Oil Recovery Wells - Cyclic Steam Operations</u>. Rule Division Staff Report, 1983.

CONTROL OF EMISSIONS FROM CRUDE OIL PIPELINE HEATERS [NO_X]

SUMMARY

Source Category: Crude Oil Pipeline Heaters

Control Methods: Oxygen Trim; Flue Gas Recirculation (FGR); Low ${
m NO}_{_{
m X}}$

Burners; Selective Catalytic Reduction (SCR); Selective Non-Catalytic Reduction (SNCR); Methanol

Emissions: (Tons/Day) Year 1985 Year 2000 Year 2010 NO_X Inventory 0.02 0.02 0.02 NO_X Reduction --- 0.01 0.01

Control Cost: \$2,000 to \$6,000 Per Ton of NO, for Combustion

Modification

\$6,000 to \$22,000 Per Ton of NO $_{_{
m X}}$ for SCR and SNCR

Other Impacts: Potential Increase in Ammonia Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

Heaters raise the temperature of heavy crude oil in pipelines to aid transport. There are an estimated ten pipeline heaters in the South Coast Air Basin. Pipeline heaters are essentially equivalent in burner design and heat input to an industrial boiler. These heaters are direct-fired and use natural gas as the primary fuel and diesel fuel for back-up.

Regulatory History

Measure A2 of the 1982 AQMP Revision proposed reductions in ${\rm NO}_{\rm X}$ emissions from pipeline heaters. No implementation action has been taken or is expected to occur prior to adoption of the this AQMP revision. Therefore, Measure A2 is being reintroduced.

PROPOSED METHOD OF CONTROL

This control measure proposes to reduce NO_X emissions through the application of controls on crude oil pipeline heaters similar to those already being used on industrial boilers. There are five different hardware-based NO_X emission control technologies under consideration for the equipment under this control measure. The technologies are: oxygen trim systems, low-NO_X burners, flue gas recirculation, selective non-catalytic reduction (SNCR), and selective catalytic reduction (SCR). These technologies are commercially available, currently in use, and are potentially capable of reducing emissions by 10 to 90 percent depending on their application.

Based on the performance of current installations and information from boiler and burner manufacturers, it appears that low-NO $_{\rm X}$ burners and flue gas recirculation could be used on most combustion units. The achievable emissions reductions with these technologies range from about 25 to 70 percent.

Because of the variety of existing combustion units, there might be certain units with unusual configurations or unusually high emissions that could not meet the NO_{X} emission reduction requirements with the use of low-NO_x burners or flue gas recirculation. Stack gas treatment techniques such as SNCR or SCR would need to be applied on these units to meet NO_{X} emission reduction requirements.

The use of methanol may offer another option for controlling NO_{X} emissions from pipeline heaters. Based on demonstrations in boilers and turbines, NO_{X} emission reductions can be achieved using methanol. Further demonstrations on pipeline heaters can verify the control efficincy of methanol.

EMISSIONS REDUCTION

The operation of crude oil pipeline heaters resulted in approximately 0.02 tons per day of NO_X in 1985. Emission estimates for 2000 and 2010 are also 0.02 tons per day. Based on a control efficiency of 25 to 90 percent, emission reductions for the years 2000 and 2010 are estimated to be 0.01 tons per day.

COST EFFECTIVENESS

Implementation of the proposed requirement would impose additional capital and operating costs on the oil industry due to equipment retrofit. For SNCR and SCR, the cost effectiveness varies from \$6,000 to \$22,000 per ton of NO_{X} reduced. The application of combustion modification will cost between \$2,000 to \$6,000 per ton of NO_{X} reduced. The costs for low-NO burners and flue gas recirculation will vary greatly with the type of combustion unit and its operating schedule. For operating schedules

typical of most units, the costs for the use of low-NO $_{\rm X}$ burners and flue gas recirculation range from about \$2,000 to \$6,000 per ton of NO $_{\rm X}$ reduced.

OTHER IMPACTS

Implementation of this measure is not expected to result in any significant adverse impacts. Additional ammonia emissions would be expected, if SNCR or SCR is used.

REFERENCES

California Air Resources Board. 1987. <u>Staff Report for Public Meeting to Consider Approval of a Suggested Control Measure for Controlling Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters. 1987.</u>

California Air Resources Board and South Coast Air Quality Management District. 1987. <u>Statewide Technical Support Document for a Suggested Control Measure for the Control of Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators and Process Heaters</u>. 1987

South Coast Air Quality Management District. 1982. <u>Final Air Quality Management Plan</u>. October 1982.

CONTROL OF EMISSIONS FROM PETROLEUM REFINERY FLUID CATALYTIC CRACKING (FCC) UNITS $[S0_{\mathbf{Y}}]$

************************ SUMMARY

Source Category: Petroleum Refinery Fluid Catalytic Cracking Units

Control Methods: Flue Gas Desulfurization and Hydrotreating Unit

Feed

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| SO_X Inventory SO_X Reduction | 18.4 | 17.5 15.8 | 18.1 16.3 |

Control Cost: \$20,000 to \$50,000 Per Ton of SO,

Other Impacts: Reduced Acid Deposition in the South Coast Air Basin;

Increased Liquid or Solid Wastes

DESCRIPTION OF SOURCE CATEGORY

Background

Presently there are several fluid catalytic cracking (FCC) units in operation at petroleum refineries located in the South Coast Air Basin to upgrade heavy distillate to lighter products. The lighter products produced include gasoline, kerosene, and heating fuels. conversion process, the heavy distillate carbon chains are broken down in the presence of heat and a catalyst. SO_X emissions occur as a byproduct of the conversion process.

The SO_{X} emissions stem from the catalyst regeneration cycle. Sulfur in the feed attaches itself to the surface of the catalyst in the cracking process and is subsequently burned off in the catalyst regeneration process.

The implementation of this tactic will provide additional SO_X reductions to help the South Coast Air Quality Management District (SCAQMD) achieve the State Sulfate Standard and the Federal $_{ extsf{PM-10}}$ Standard. The proposed control limit is below the level set by New Source Performance Standards (NSPS) criteria.

Regulatory History

At the present time, SO_X emissions from FCC units are regulated under District Rule 1105. This rule was initially promulgated in 1978 as a tactic toward achieving the State SO_2 and Sulfate Standards. The current emission limit for FCC units is 132 pounds of SO_X per thousand barrels of feed charged. The refineries have achieved this emission limit by varying combinations of reducing the sulfur content of the incoming feed and the use of SO_X reducing catalysts.

Measure Al in the 1982 Revision to the AQMP proposed more stringent limits on SO_X emissions than currently contained in Rule 1105. That measure envisioned the utilization of flue gas treatment technology to meet lower emission levels. No implementation action has been taken relative to measure Al or is expected to occur prior to adoption of this AQMP Revision. Therefore, the concept of further reducing SO_X emissions from FCC units is being reintroduced here.

PROPOSED METHOD OF CONTROL

This control measure aims to reduce ${\rm SO}_{\rm X}$ emissions from all fluid catalytic cracking units used in petroleum refineries located in the District. This control measure calls for reducing FCC ${\rm SO}_{\rm X}$ emissions by 90 percent from the current emission limit as specified by Phase II of Rule 1105. The current limit of Rule 1105 is 132 pounds of ${\rm SO}_{\rm X}$ per thousand barrels of feed charged to the FCC; a 90 percent reduction would change this limit to 13.2 pounds.

To achieve the proposed level of control it can be anticipated that a combination of flue gas treatment, special catalyst, and possible additional pretreatment of the FCC feed will be utilized by the refineries. One available option for flue gas treatment is the use of a sodium-based wet gas venturi scrubber process. The special catalyst mentioned above is a SO_{x} type that is mixed in with the normal FCC cracking catalyst. The penalty for using this catalyst is to reduce, somewhat, the fraction of gasoline component yield from the FCC. The third control option, feed pretreatment, would include some additional form of hydrodesulfurization process, or the use of a SO_{x} reducing catalyst in the FCC unit.

EMISSIONS REDUCTION

During 1985, FCC units emitted 18.5 tons per day of SO_χ in the South Coast Air Basin. In the years 2000 and 2010, SO_χ emissions from this source category are expected to be 17.5 tons per day and 18.1 tons per day, respectively. As already noted, implementation of this measure is expected to further reduce SO_χ emissions from FCC units by 90 percent. Based on a

90 percent control factor, SO_X emissions will be reduced by 15.8 tons per day in the year 2000 and 16.3 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed requirements would impose additional capital and operating costs on the refineries due to equipment retrofit costs. The cost effectiveness for implementing the control measure varies from \$20,000 to \$50,000 per ton of SO_X reduced. The variation in cost is contributed to the type of FCC unit and its operating schedule.

OTHER IMPACTS

Implementation of this SO_X control measure will reduce acid deposition in the South Coast Air Basin. There also may be increased liquid or solid wastes as by-products of desulfurization processes.

REFERENCES

South Coast Air Quality Management District. 1978. <u>Sulfur Dioxide/Sulfate Control Study</u>.

South Coast Air Quality Management District. 1982. <u>Final Air Quality Management Plan</u>.

CONTROL OF EMISSIONS FROM PETROLEUM COKE CALCINING OPERATIONS [SO_X]

SUMMARY

Source Category: Petroleum Coke Calcining Operations

Control Methods: Flue Gas Desulfurization (e.g., Limestone Process)

Emissions: $(Tons/Day) \qquad \underline{Year\ 1985} \qquad \underline{Year\ 2000} \qquad \underline{Year\ 2010}$ $SO_X \ Inventory \qquad 2.2 \qquad \qquad 2.2 \qquad \qquad 2.2$ $SO_X \ Reduction \qquad --- \qquad Not \ Determined$

Control Cost: Not Determined

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

Petroleum refineries supply raw material for coke calciners. In the refining process, crude stocks are fractionated into useful products such as gasoline, kerosene, diesel fuel, and heating oil. The still bottoms are usually coked to maximize removal of the volatile materials. The material remaining is sold as green coke. Calcining is a high temperature drying process in which hot combustion gases flow over and through green petroleum coke. At operating temperatures of up to 2400° F, moisture (9 to 11 percent by weight) and tar (0.4 to 0.6 percent by weight) vaporize. The dry coke product is used for electrodes in the refining of aluminum from bauxite ore, motor brushes, and dry cells.

Regulatory History

Measure Al3 of the 1982 AQMP Revision was adopted to reduce SOx emissions to meet the state sulfate standard. No implementation action has been taken or is expected to occur prior to adoption of the this AQMP revision. Therefore, measure Al3 is being reintroduced.

District Rule 1119 presently regulates petroleum coke calcining operations, requiring an 80 percent reduction in oxides of sulfur emissions from coke calcining operations.

PROPOSED METHOD OF CONTROL

This control measure aims to increase the minimum level of SOx reductions from 80 percent to 90 percent for coke calcining operations. Since the single source of this kind in the District already meets the 90 percent standard, the proposed measure will not reduce emissions, but will ensure future operations continue at the level.

Limestone flue gas desulfuring systems are currently available which would allow new facilities to achieve the 90 percent control level.

EMISSIONS REDUCTION

The 1985 ${\rm SO}_{\rm X}$ emissions from coke calciners located in the Air Basin were about 2.2 tons per day. No additional emission reductions are expected for this facility, but may occur if additional calciners are located in the Basin.

COST EFFECTIVENESS

There is no cost impact on the existing source. Cost effectiveness will be analyzed in the future, when new facilities are added to the Basin.

OTHER IMPACTS

There are no adverse impacts expected from implementation of this measure.

REFERENCES

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. October 1982.

South Coast Air Quality Management District. 1978. <u>Sulfur Dioxide/Sulfate</u>

CONTROL OF EMISSIONS FROM GAS FIRED PETROLEUM REFINERY PROCESS HEATERS [PM]

<u>SUMMARY</u>

Source Category: Petroleum Refinery Process Heaters

Control Methods: End-pipe Treatments (e.g., Electrostatic

Precipitators)

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| PM Inventory PM Reduction | 2.6 | 2.6 2.3 | 2.6 |

Control Cost: \$12,000 Per Ton of PM

Other Impacts: Increased Solid Wastes

DESCRIPTION OF SOURCE CATEGORY

Background

Petroleum refinery process heaters are used to transfer heat from combustion of fuels to fluids in petroleum refining processes such as distillation, fluid catalytic cracking, catalytic reforming, and hydrotreating. In the South Coast Air Basin (SCAB), there are about 300 refinery process heaters spread over 15 refineries (SCAQMD, 1986). Most of these refineries are located in the city of Wilmington and the surrounding areas. The refinery process heaters are fired with a variety of refinery by-product fuels (high viscosity oils and high molecular weight gases) with make-up fuels such as natural gas and liquefied petroleum gas (LPG).

In SCAB, 92 percent of particulate emissions from petroleum refinery process heaters have areodynamic diameters less than 2.5 microns (Gray, 1986). Two factors contributing to particulate emissions from these heaters are combustion conditions and fuel composition. Inadequate combustion conditions could result in the release of unburned and partially burned hydrocarbons and/or carbon into the atmosphere. High molecular

weight fuels generally contribute to higher particulate emissions than lighter fuels.

Regulatory History

At present, particulate emissions from petroleum refinery process heaters are uncontrolled. In order to attain the state ambient air quality standards (24 hour and annual) for particulate matter being violated in many areas of the Basin, PM emissions should be reduced. The control measure proposed in the following section is directed to reduce PM emissions from petroleum refinery process heaters.

PROPOSED METHOD OF CONTROL

End-pipe controls such as electrostatic precipitators, or baghouse filters are proposed to reduce PM emissions from refinery process heaters. Since these control technologies are continuously being refined and are competitive in cost as well as their efficiencies, the selection of a particular control technology should be left to the concerned industry.

The selection of baghouse filters or electrostatic precipitators for controlling PM emissions from refinery process heaters is based on their capability to collect submicron size particles with high efficiencies. For a baghouse filter, woven fabric such as cotton or felted material such as fiberglass is used to remove particles from the gas stream. Initially, particles are captured by the fibers of the filter by means of interception, impingement, diffusion, gravitational settling, and electrostatic attraction. Once a dust mat is formed on the filter, all the above processes and sieving facilitate further removal of particulates from the gas stream. Depending on the carrier gas and particulate characteristics, appropriate filtering media must be used.

Electrostatic precipitators use an electrostatic field to remove liquid and solid particles from the carrier gas. Gas ions formed as a result of high voltage corona discharge in precipitators, impart their charge to the particles present in the carrier gas by bombarding them. The charged particles migrate to a collecting electrode of opposite polarity where their charge is neutralized. For the efficient working of the precipitator, particle re-entrainment in the main gas stream must be prevented. The re-entrainment of the particles depends on particulate characteristics, particularly their electrical resistivity. Since electrical resistivity varies with temperature and moisture, the latter also affects the collection efficiency of a precipitator.

Since the collection efficiencies of the above control devices depend on a number of factors such as particle characteristics (physical and chemical), properties of carrier gases (temperature and moisture content), and grain or dust loading, installation of some auxiliary systems may be necessary for PM collection from the refinery heater flue gases. For example, heat exchangers may be required to reduce the temperature of the exhaust gas

stream to a level acceptable to the control device. Since the grain loading of gas-fired refinery heater exhaust is low (approximately 0.005 grains/cubic feet), precoating of the filter with a material such as limestone may be required to capture small size particles from the gas stream.

The use of venturi and collision scrubbers as end-pipe treatments for reducing PM emissions from the refinery heater flue gases was also studied as one of the control options. The information collected from the vendors of venturi and collision scrubbers revealed that at present, the latter are less cost-effective for PM control of the refinery heater flue gases than the proposed controls.

FMISSIONS REDUCTION

In 1985, gas fired petroleum refinery process heaters emitted about 2.6 tons per day of PM in the South Coast Air Basin. In the years 2000 and 2010, PM emissions from this source category are also expected to be 2.6 tons per day. Based on a 90 percent efficiency, the PM emissions reduction are estimated to be 2.3 tons per day in the years 2000 and 2010.

COST EFFECTIVENESS

To install an ESP unit at a given site with 12,000 cfm of exhaust flow, the cost effectiveness of this control measure is estimated to be \$12,000 per ton of particulate reduced. If cooling water is required to reduce the temperature of the exhaust flow prior to entering into an ESP, the control cost is estimated to be \$22,000.

OTHER IMPACTS

The proposed measure would generate solid waste collected by the control equipment. Depending on its composition, this waste may be classified as a hazardous or special waste that it should be disposed of in a classified landfill. Since the solid waste generated by the proposed control measure is small in quantity, the additional burden of waste disposal will be minor.

REFERENCES

Gray, H. A. 1986. <u>Control of Atmospheric Fine Primary Carbon Particle Concentrations</u>. EQL Report 23, California Institute of Technology, Pasadena. 1986.

South Coast Air Quality Management District. 1986. "Automated Equipment Inventory System". El Monte, CA. 1986.

IMPROVED CONTROL OF EMISSIONS FROM . PETROLEUM REFINERY FLUID CATALYTIC CRACKING UNITS [PM]

<u>SUMMARY</u>

Source Category: Petroleum Refinery Fluid Catalytic Cracking Units

Control Methods: Improve Operation of Existing Control Equipment;

Equipment Replacement; Feed Retreatment

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| PM Inventory | 1.1 | 1.1 | 1.2 |
| PM Reduction | | 1.0 | 1.1 |

Control Cost: \$29,300 Per Ton of PM

Other Impacts: Increased Solid Wastes

DESCRIPTION OF SOURCE CATEGORY

Background

Several refineries in the Basin employ fluid catalytic cracking (FCC) units to aid in the cracking process to produce gasoline and other petroleum products from heavy distillate oils. Aluminum silicate is commonly used as a catalyst in this process. The catalyst is used in the form of a powder or dust. During the cracking process some of the cracked hydrocarbons that are formed as coke end up as a deposit on the catalyst. This surface coating of coke results in eventual deactivation of the catalyst. To regenerator. During the regeneration a chemical reaction takes place in electrostatic precipitators are used to recover the regenerated catalyst. A CO boiler is used, subsequently, to burn the flue gases from the carbon may result from the regeneration process or when the catalyst goes through the CO boiler.

Regulatory History

This is a new proposed measure for the control of PM emitted from FCC units. District Rule 404 currently regulates the particulate matter emissions from FCC units in the Basin with specificed emission limits.

PROPOSED METHOD OF CONTROL

This control measure is directed at reducing PM emissions resulting from the release of catalyst and carbon during the catalyst regeneration process in fluidized catalytic cracking units at petroleum refineries. The measure will also reduce coke/carbon emissions from the regeneration unit.

One proposed emission control method to reduce PM emissions would be to improve the operation of electrostatic precipitators (ESP) and cyclones, presently installed on the catalytic cracking units or possibly to replace older equipment with newer, more efficient models.

Another control method is to hydrotreat the feed entering the FCC units since it will reduce SO_{χ} emissions which will in turn reduce particulate formation (See CM #88-B-8). A combination of the above approaches will probably be used to comply with the requirements of the proposed control measure depending on the specific FCC unit design, operation, and site.

EMISSIONS REDUCTION

During 1985, FCC units emitted about 1.1 tons per day of PM in the South Coast Basin. In the years 2000 and 2010, PM emissions from these units are expected to be about 1.1 tons per day and 1.2 tons per day, respectively. The proposed control approaches will reduce PM emissions by about 90 percent. Potential emission reductions are therefore, estimated to be 1.0 ton per day in the year 2000 and 1.1 tons per day in the year 2010.

COST EFFECTIVENESS

The control cost based on installation of a new ESP unit is estimated to be \$29,300 per ton of PM reduced.

OTHER IMPACTS

Proper disposal of the captured particulate matters must be considered. Implementation of this control measure will result in additional particulate collection, thus creating additional solid wastes.

REFERENCES

South Coast Air Quality Management District. 1982. <u>Final Air Quality Management Plan</u>. October 1982.

U.S. Environmental Protection Agency. 1985. <u>Operation and Maintenance Manual for Electrostatic Precipitators</u>. EPA/625/1-85/017. 1985.

CONTROL OF EMISSIONS FROM OCS EXPLORATION, DEVELOPMENT, AND PRODUCTION [ALL POLLUTANTS]

SUMMARY

Source Category: OCS operations in California Coastal Waters

Control Methods: Engine Modifications; Alternative Fuels;

Inspection & Maintenance Programs; Platform

Electrification

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | | 5.5 | 5.5 |
| ROG Reduction | | 5.3 | 5.3 |
| NO_X Inventory NO_X Reduction | | 8.5 8.1 | 8.5 8.1 |
| SO_X Inventory SO_X Reduction | | 0.6 0.5 | 0.6 0.5 |
| PM Inventory | | 0.2 | 0.2 |
| PM Reduction | | 0.1 | 0.1 |
| CO Inventory | | 2.1 | 2.1 |
| CO Reduction | | 1.9 | 1.9 |

Control Cost: \$24,800 Per Ton of ROG or

\$16,200 Per Ton of NO_X

Other Impacts: Decreased Emission of Toxic Air Contaminants;

Increased Hazardous Waste Disposal

DESCRIPTION OF SOURCE CATEGORY

Background

The Minerals and Management Service (MMS) has estimated that 462 million barrels of oil (mbbl) and 726 billion cubic feet of gas (bcf) will be

produced from the offshore Southern California Coastal region over a 35-year period. It is also estimated that there will be approximately 200 exploration wells and 475 production wells on .0-15 platforms. It is unknown how many of these platforms will be located within an area affecting the South Coast Air Basin.

The types and relative amounts of air pollutants generated by Outer Continental Shelf (OCS) operations vary according to the phase of activity. There are basically three phases: exploration, development, and production.

In the exploration phase, emissions are produced by diesel-fired power generating equipment needed for drilling, support boats, and intermittent operations such as mud degassing and well testing. Pollutants consist primarily of NO_{X} , CO , ROG , and SO_{X} .

Typical emission sources in the development phase are: diesel and natural gas driven turbines providing power for drilling activities, heavy equipment used to install platforms and pipelines, and support boats. The largest contaminant emitted in the development phase is NO_{χ} with CO, ROG, SO_{χ} , and PM contributing lesser amounts.

During the production phase, the principal source of emissions is from natural gas turbines that provide power for oil pumping, water injection, and gas compression. The emissions are primarily NO $_{\rm X}$, with lesser amounts of CO, ROG, PM, and SO $_{\rm X}$. Other sources include leakage of ROG from oil/water separators, pump and compressor seals, valves and storage tanks. Periodic flaring of gas results in some SO $_{\rm X}$ and ROG emissions. Onshore gas processing results in NO $_{\rm X}$ emissions and lesser amounts of ROG and CO.

Additional emissions would occur if barges or tankers are used to transport crude to shore. ROG emissions would result from tanker loading and unloading operations. Emissions of NO_X , SO_X , and PM from the ships engines occur during loading, transit, and port operations.

Regulatory History

The District does not have any source specific rules for OCS operations at present. However, the District is currently participating in a multiagency/industry effort to develop a framework for an OCS specific rule that could be applied statewide. This control measure is based largely on proposals District staff has made to the multiagency/industry working group.

PROPOSED METHOD OF CONTROL

The proposed control measure is directed toward the emission control of NO_X , SO_X , ROG, CO, and PM from OSC operations. The specific measures for each phase are discussed as follows:

Exploration Phase

During the exploration and platform installation phase, diesel engines used as power supply and on board ships and barges could reduce emissions by injection time retard, selective catalytic or non-catalytic reduction for NO $_{\rm X}$ control, and low sulfur fuel for SO $_{\rm X}$ control. Other alternatives for emission reductions from reciprocating engines involve the use of gas turbines, natural gas instead of diesel, and alternative fuels such as methanol. Improved engine design/operations will also lower emissions through pre-combustion chamber redesign, exhaust gas recirculation, and maintenance of proper fuel to air ratio.

Development and Production Phase

Platform electrification can replace diesel engines or gas turbines as platform power sources in this phase for effective control of NO_{X} and ROG emissions. However, an all-electric platform will still require emergency generators, fire pump system, cranes, cementing engines, crude oil heaters, and other equipment, which will add a relatively small amount of emission as compared to that from the main power generating equipment.

An Inspection and Maintenance program for fugitive ROG emissions should be instituted for valves, pumps, compressors, pressure relief valves, and flare systems. Flares can also be controlled by alternative pilot systems, use of $\rm H_2S$ scrubbers, low $\rm NO_X$ equipment, and "smokeless" flares. For marine vessels, engine emission reduction techniques mentioned above are also applicable.

In addition, vessel management techniques should also be utilized and include optimization of boat speeds, programmed boat trips and vessel schedules, and use of helicopters for crew transport. Transportation of the crude and gas via pipeline to the shore is the most effective means of controlling ROG emissions from tanker loading/unloading, and reducing NO_{X} , SO_{X} , and PM emissions from tanker operations.

EMISSIONS REDUCTION

In 1985, there were not any OCS operations in California coastal waters. The expected emissions from this source category for the years 2000 and 2010 are listed in the summary table. The emissions inventory for the year 2010 is assumed to be the same as for the year 2000, until further data becomes available. The maximun ROG and NO $_{\rm X}$ emission reductions which could occur are about 95 percent. The maximum SO $_{\rm X}$ and CO emission reductions are about 90 percent, and the maximum PM emission reductions are about 80 percent. Based on the above control efficiencies, the potential emissions reduction for the years 2000 and 2010 are also listed in the summary table.

COST EFFECTIVENESS

A preliminary cost effectiveness study has been completed for OCS BACT Protocols (York, 1987). Assuming electrification to be used, the control costs for ROG and NO $_{\rm X}$ are \$24,800 per ton of ROG (or \$16,200 per ton of NO $_{\rm X}$). Cost estimates for PM, SO $_{\rm X}$ and CO are ignored, since emission reductions are negligible.

OTHER IMPACTS

This measure may require additional authority or legal clarification regarding the jurisdiction of SCAQMD and the Department of Interior over California Coastal Waters, and any conflicts thereof.

The impact of pollutants generated at sea on South Coast Air Basin largely depend on ocean meteorology, and specifically on wind flow direction. The maximum transport of pollutants from sea to land occurs in summer, when the Los Angeles area experiences 81 percent onshore flow and 16 percent offshore flow. The reversal of wind direction in winter causes only 43 percent onshore flow and 53 percent offshore flow, reducing the transport of emissions to land. Further modeling or test studies may be required to quantify this temporal effect on criteria pollutants generated by OCS activity.

The proposed requirements are also expected to decrease toxic air contaminant emissions, but may increase solid or liquid hazardous wastes. Additional study is also required for toxic air contaminants and disposal of hazardous solid and liquid wastes.

REFERENCES

Department of Interior, Minerals and Management Service. 1987. <u>Proposed 5-year OCS Oil and Gas Leasing Program 1/87-12/91</u>, Draft EIS Table II.A.1.b-3.

Department of Interior, Minerals and Management Service. 1987. Proposed 5-year OCS Oil and Gas Leasing Program 1/87-12/91, Draft EIS Table II.A.l.b-1.

York, S. 1986. <u>South Coast Air Quality Management District Memorandum, Review of Proposed 5-year OCS Oil and Gas Leasing Program, Draft EIS.</u>

York, S. 1987. <u>South Coast Air Quality Management District Memorandum.</u>
<u>Draft of OCS BACT Protocols.</u>

CONTROL OF EMISSIONS FROM PETROLEUM REFINERY FLARES [ALL POLLUTANTS]

SUMMARY

Source Category: Petroleum Refinery Flares

Control Methods: Step I--Monitoring of Flare Operations, Evaluation

and Recommendation of Control Technologies

Step II--Implementation of Control Technologies

Developed in Step I

Emissions: Not Determined

Control Cost: Not Determined

DESCRIPTION OF SOURCE CATEGORY

Background

Blowdown systems are designed and installed at petroleum refineries to provide for safe containment or safe release of liquids and gases which must be vented. These systems are used for emptying and venting vessels during scheduled maintenance and turn-around or during emergency upsets. Such systems generally consist of a series of venting manifolds which lead from the process equipment to a blowdown recovery subsystem (e.g., storage tanks) and flares.

Flares are incendiary devices which ensure safe combustion of waste gases when the blowdown volume exceeds the storage capacity of the recovery subsystem. Thus, they provide the last opportunity to treat blowdown gases before they are released into the atmosphere.

In 1984, the California Air Resources Board contracted with ${\rm CH_2M\ Hill}$, an engineering firm, to evaluate the feasibility of continuously monitoring petroleum refinery, an engineering firm, flare emissions. Based on ${\rm CH_2M\ Hill's}$ analysis and public testimony, the California Air Resources Board has determined that monitoring devices are technologically feasible,

available, and economically reasonable to identify and record continuously the on/off status of refinery flares for the purpose of determining refinery flare emissions. The Board also directed its staff to work with local districts to develop rules requiring the use of these devices and to encourage the districts to require refiners to provide grab sample composition analysis of flare feed stream gases. In addition, the Board directed its staff to evaluate monitoring data and to prepare recommendations regarding development of the proposed Suggested Control Measure.

Regulatory History

Measure A15 of the 1982 AQMP Revision proposed increasing the use of blowdown recovery systems to reduce emissions from flare operations. Measure A15 was originally scheduled for adoption in 1985. Consideration of adoption, however, was postponed to provide additional time to collect background information regarding flare operations and alternative control options. The California Air Resources Board, the District, and other local Air Pollution Control Districts (APCD) staffs have been working to collect this information. Data collection and analysis have reached a point where it is appropriate to repropose the measure in a modified form. In addition, flare operations are currently identified on the statewide list of Suggested Control Measures (SCM) as a possible area of future action.

PROPOSED METHOD OF CONTROL

This measure is directed at determining the air pollutant emissions inventory for refinery flare operations and implementing emission controls if they are warranted.

A two step approach is called for based on current information. During step I, refinery facilities will be required to monitor their flare operations. This will consist of the use of automatic on/off status monitors and feed gas monitoring for flow and composition. The monitoring data will be examined to determine the frequency and duration of flare operations within the Basin. This baseline information will be used to develop emission factors and an associated improved emissions inventory. The inventory will be examined to determine if flare operations represent a significant source of emissions. If flare operations are a significant source of emission, step II of the measure will be implemented (i.e., emission controls) in addition to the required monitoring. If flare operations are not a significant source of emissions, step II will not be implemented.

For Step I, the program objectives are:

- 1. Provide continuous daily flow measurements and recordkeeping of the vent gas releases to each flare.
- 2. Provide continuous daily steam flow measurements and the steam to hydrocarbon ratio used at each flare.

- 3. Measure and record properties of all vent gases to each flare on a weekly basis (i.e., sulfur content and gross heating value of the organic species).
- Provide information for updating emission factors for all criteria pollutants at each refinery flare.
- Provide information requested for a one-year period including cost and availability information according to schedule.

In addition to the objectives described above, the District has asked ARB to check with EPA to see if the following information could be provided by EPA:

- 1. Organic flaring rates for vent gas flow rates varying from low to high, and their thermal destruction efficiencies from EPA's own or contracted studies.
- The toxic portion of the flared emissions.

When Step II is developed, two control actions may be considered. One action is to increase the capacity of blowdown recovery, thereby reducing the amount of gas flowing to the flare. The other action is to improve flare design and operating parameters to improve combustion characteristics. Examination of these control options, and any constraints to their use will be performed together with emission monitoring efforts.

EMISSIONS REDUCTION

The emissions reduction from this source category will be determined at a later date based on the results of Step I studies and the control option selected.

COST EFFECTIVENESS

The cost effectiveness of the proposed control measure will be determined at a later date based on the results of Step II studies. However, Step I of the measure, emissions monitoring, will result in additional operating costs for some facilities, whereas others are already performing such monitoring as part of their operations. If analysis of the monitoring data shows that emission controls are needed, additional control equipment will be required at most refineries. The capital costs that result from enhancing the capacity of blowdown systems will be offset to some degree by the sale and use of recovered products.

OTHER IMPACTS

Implementation of this measure will result in minor administrative costs to the District for engineering permit review and enforcement activities. There are no negative environmental impacts associated with this measure at the present time.

REFERENCES

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. October 1982.

FURTHER EMISSION REDUCTIONS FROM VALVES, PUMPS, AND COMPRESSORS USED IN OIL AND GAS PRODUCTION FIELDS, REFINERIES, AND CHEMICAL PLANTS [ROG]

SUMMARY

Source Category: Oil and Gas Production Fields, Chemical Plants

and Petroleum Refineries

Leakless Equipment; "Leak = Violation" Approach; Control Methods:

Greater "Self-Enforcement" by Operators; Methane

as the Reference and Calibration Gas

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | Year 2010 |
|--------------------------|------------------|------------------|-----------|
| ROG Inventory | 12.7 | 12.7 | 13.0 |
| ROG Reduction | | 11.4 | 11.7 |

Control Cost: \$15,000 Per Ton of ROG

Other Impacts: Decreased Emission of Toxic Air Contaminants and

Hazardous Liquid Wastes

DESCRIPTION OF SOURCE CATEGORY

Background

Many types of valves are used by the petroleum, petrochemical, and chemical industries to regulate or control the flow of organic liquids and gases. Pumps are used to move light and heavy liquids, whereas compressors move gases by raising their pressures. All of the above equipment may develop leaks with use due to normal wear and tear, with the subsequent emissions of ROG into the atmosphere. The problem is aggravated by the use of older equipment and may be mitigated to some extent by regular detection, preventive maintenance, and repair programs.

Regulatory History

Fugitive ROG emissions from pumps and compressors, valves, and pressure relief valves are regulated under District Rules 466, 466.1, and 467. These rules require facility operators to implement leak detection and repair programs for valves, pumps, and compressors. Specific inspection intervals, detection criteria, recordkeeping, and repair procedures are stipulated by the provisions of the rules.

The application of these rules to petroleum refineries, oil and gas production fields, and chemical plants has resulted in a net decrease of fugitive ROG emissions. Additional improvements in these rules are possible which will provide for greater control effectiveness.

PROPOSED METHOD OF CONTROL

Further reduction of fugitive emissions is possible through the required use of modern "leakless" equipment; substitution of current inspection and maintenance (I & M) procedures with "leak = violation" approach; and greater use of a "self-enforcement" approach by the operators. The proposed control measure calls for a blending of these three control approaches. This control measure also recommends the replacement of hexane by methane as the reference and calibrating compound for the portable leak detection device.

Leakless Equipment

"Leakless" refers to equipment or components which are characterized by negligible fugitive emissions as compared to their standard counterparts. The use of such equipment provides a preventive approach based on improved technology as opposed to the current practice based on detection and repair. Leakless equipment may be either installed new or retrofitted to existing systems. Leakless alternatives exist for most but not all valves, pumps, and compressors in service in the previously designated industries.

The leakless valve design which appears most suitable is the sealed bellows valve. Metal bellows are used in this valve type to isolate the stem from the process fluid. This eliminates the major cause of fugitive emissions, namely, process fluid (or gas) leaking around the stem packing to the atmosphere. These valves are particularly suitable for refinery and chemical plant applications since they can be designed to withstand high temperatures and pressures. At the present time sealed bellows valves are only available in a limited size range in globe, gate and ball configurations. The District's New Source Review requirements establish the sealed bellows type or equivalent as BACT for industrial process valves.

For pumps, dual mechanical seals and ignore designs (canned motor) are leakless alternatives to standard equipment. The design utilizing dual mechanical seal consists of two mechanical sealing elements with a barrier fluid circulating between the seals. The barrier fluid isolates the process stream from the atmosphere, thus reducing fugitive emissions. Water, glycols, and methanol are examples of substances which have been used as barrier fluids. Dual mechanical seals are already used in some

refinery applications, but are not suitable in applications above 260°C or for pumps with reciprocating shaft motion.

Another alternative to the standard pump is the ignore or canned motor variety. As the name implies, all seals are eliminated in these designs. The pump casting and rotor housing are interconnected and the impeller, rotor and bearings are completely enclosed. Only a small portion of the process fluid is used to provide lubrication and cooling for the bearings and rotor. Because the process fluid serves as the lubricant, these pumps are only suitable for relatively clean process streams which do not contain abrasive solids. In addition, mechanical and packed seal pumps cannot be retrofitted for ignore operation.

With respect to compressors, fugitive emissions principally occur at the junction of the moving shaft and stationary casing. Mechanical seals with a barrier fluid, liquid film seals, seal area enclosures, scavenger systems, and controlled venting systems are techniques available to achieve leakless operation of compressors. The applicability of these techniques is strongly dependent on compressor design. Mechanical seals, liquid film seals, seal area enclosures, and controlled venting systems appear suitable for centrifugal and rotary compressors, whereas scavenger systems, seal area enclosures and controlled venting systems appear suitable reciprocating compressors. Scavenger systems are those created by inserting spacer rings into the existing packing and connecting the newly created void area to a collection system. Mechanical and liquid film seal both control emission through the use of a fluid injected into the seal at a pressure greater than the internal pressure of the compressor. prevents fugitive emissions from escaping around the shaft as long as the Seal area enclosures are suitable for those seal remains intact. situations where the other techniques cannot be applied.

For both pumps and compressors, the District's New Source Review requirements specify double mechanical seals, single mechanical seals, glandless pumps, enclosure and venting to a vapor recovery system, and enclosure and venting to a vapor disposal system as BACT for industrial processes.

Leakless equipment will be phased-in to replace existing older equipment at the rate of 33 percent per year. Although a number of leakless designs could currently be used in lieu of standard equipment, it is unlikely that such designs will be suitable in every instance.

Leak = Violation Approach

Current rules require operators to attempt to repair leaks within a specified time interval after detection. Repair procedures allow certain components to remain in operation until a scheduled system shut-down if the initial repair is unsuccessful. Operators are also required to maintain records of inspection for up to two years and produce them for inspection by District personnel upon demand.

In the new approach, the detection of a leak by District staff would amount to a violation. This approach is logically recommended after the changeover to leakless equipment is completed, and in conjunction with the next control measure involving greater "self-enforcement" efforts. It also offers some cost savings by eliminating recordkeeping, documentation, identification of leaking components, and other requirements. Operators would be free to set their own I & M schedules to suit their individual requirements. Other compliance approaches would include: component redundancy, venting leaks to control devices, and purchasing offsets or petitioning for a variance. A strong enforcement effort by the District would be required for successful implementation of the "Leak = Violation" approach.

This concept has been previously proposed by the District staff, but abandoned when it appeared that EPA would not grant approval under the State Implementation Plan. EPA subsequently recommended this approach under the proposed Reasonable Extra Efforts Program, which lends further support for reintroduction of this feature.

<u>Greater "Self-Enforcement" by Operators</u>

This concept is advanced in connection with the previous approach and will replace District prescribed I & M requirements. Users and operators will design and implement their own I & M programs, after the changeover to leakless equipment, to ensure that their equipment will achieve and maintain the lowest emission levels. To provide the required level of expertise, the District may implement a licensing or certification scheme for users or sub-contractors. The District will reserve the right to inspect the equipment at any time and at its discretion in order to implement the "Leak = Violation" approach.

Methane as the Reference and Calibration Compound

District Rules 466, 466.1, and 467 established hexane as the reference and calibration gas for determining gas leaks from pumps, compressors, valves, flanges, and pressure relief valves. EPA Region IX has requested the substitution of hexane by methane as part of the proposed Reasonable Extra Efforts Program. A recent study by Radian (1987) has also advocated this change to make the South Coast District consistent with other districts, although there is no clear evidence that the recommended change will lead to reduction in fugitive emissions. Further consideration of this concept is recommended in light of the above developments.

EMISSIONS REDUCTION

The 1985 fugitive ROG emissions from valves, pumps, and compressors in the South Coast Air Basin is estimated at 12.7 tons per day. In the years 2000 and 2010, emissions are expected to be about 12.7 tons per day and 13.0 tons per day, respectively. It is assumed that a 90 percent reduction of emissions is possible if all of the control actions mentioned above are

implemented. Therefore, the emission reduction in the years 2000 and 2010 are estimated at 11.4 tons per day and 11.7 tons per day.

There are several uncertainties associated with these estimates, mostly arising from the determination of emission factors and the distribution of leak frequency among components, including both leakless and standard equipment.

Additional study is required to determine the specific applications for leakless equipment, their leak rates, reliability, and durability, and quantification of the emission benefits of "Leak = Violation" approach and "Greater Self-Enforcement" approach. All of these factors will affect the emission reduction potential. The estimates presented above, however, are conservative and judged to be realistic based on current data.

COST EFFECTIVENESS

The costs of new or retrofit equipment and installation would be partially offset by decreased costs of repair and maintenance, decreased costs of inspection and recordkeeping, and the value of product recovered.

Initial calculations based on average size equipment and average emission rates (Radian, 1987) produced the following cost effectiveness factors (C/E), classified by equipment and type of service.

| Equipment | Service | C/E (\$/ton) of ROG reduced) |
|-------------|--------------|------------------------------|
| Valves | Gas | 4,000 |
| Valves | Light liquid | 30,000 |
| Valve | Heavy liquid | 72,000 |
| Pumps | Light liquid | 4,000 |
| | Heavy liquid | 20,000 |
| Compressors | Gas | 3,000 |

The reason for the lower cost factor for gas valves lies in them higher average rate of ROG emissions as compared to a valve in heavy liquid service. The lowest cost factor, indicating the most effective control, belongs to compressors because they have the highest emission factor among all components studied herein. The above results indicate that present technology may not be cost-effective to reduce ROG emissions from valves on heavy liquid streams. Excluding valves in heavy liquid service, the weighted average cost of control is about \$15,000 per ton of ROG reduced.

OTHER IMPACTS

Implementation of this measure will provide additional benefits of reduced exposure to toxic air contaminants (e.g. benzene), increased product saving due to less product loss, decreased odor nuisance, and possible decrease in groundwater contamination. There are no adverse environmental impacts associated with this control measure.

REFERENCES

Radian. 1980. <u>Assessment of Atmospheric Emissions from Petroleum Refining</u>, Vol. 3. App. B EPA-600/2-80-075C. EPA IERL, Research Triangle Park, NC. April 1980.

Radian. 1987. <u>Assessment of Fugitive Emissions of Proc from Petroleum Refining Operations</u>. Radian, Sacramento, CA. May 1987.

Rockwell International. 1980. <u>Fugitive Hydrocarbon Emissions from Petroleum Production Operations</u>. Vols. I & II. API, Washington, D.C. March 1980.

CONTROL OF EMISSIONS FROM OIL FIELD STEAM GENERATORS [NOx]

SUMMARY

Source Category: Oil Field Steam Generators

Oxygen Trim; Flue Gas Recirculation (FGR); Control Methods:

Low NO_X Burners; Selective Catalytic Reduction (SCR); Selective Non-Catalytic Reduction (SNCR)

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 0.6 | 0.6 | 0.6 0.4 |

 $$2,000 \text{ to } $6,000 \text{ Per Ton of NO}_x \text{ for Combustion}$ Control Cost:

Modification

\$6,000 to \$22,000 Per Ton of NO $_{_{
m X}}$ for SNCR and SCR

Other Impacts: Potential Increase in Ammonia Emissions **************

DESCRIPTION OF SOURCE CATEGORY

Background

Oil field steam generators are used to produce steam for injection into oil wells, and thus thermally enhance oil recovery. During the combustion process, oxides of nitrogen are produced and released to the atmosphere. This control measure is aimed at decreasing these NO_x emissions.

Regulatory History

Measure Al6 of the 1982 AQMP Revision was originally proposed to reduce NO_X emissions from this source category. Efforts are currently underway in Rule Development but are not completed. Therefore, Measure Al6 is being reintroduced.

PROPOSED METHOD OF CONTROL

There are five different hardware-based NO_X emission control technologies under consideration for the equipment under this control measure. The technologies are: 1) oxygen trim systems; 2) low- NO_X burners; 3) flue gas recirculation; 4) selective non-catalytic reduction (SNCR); 5) and selective catalytic reduction (SCR). These technologies are commercially available, currently in use, and are potentially capable of reducing emissions by 10 to 90 percent depending on their application.

Based on the performance of current installations and information from boiler and burner manufacturers, it appears that low-NO $_{\rm X}$ burners and flue gas recirculation could be used on most combustion units. The achievable emissions reductions with these technologies range from about 25 to 70 percent.

Because of the variety of types of existing combustion units there might be certain units with unusual configurations or unusually high emissions that could not meet the NO_{X} emission reduction requirements with the use of low-NO_x burners or flue gas recirculation. Stack gas treatment techniques such as SNCR or SCR would need to be applied on these units to meet NO_x emission reduction requirements. It is believed that there are no combustion units that could not be retrofitted with at least one of the above-mentioned control technologies to meet NO_x emission reduction requirements.

EMISSIONS REDUCTION

The operation of oil field steam generators resulted in approximately 0.6 tons per day of NO_X in 1985. Emission estimates for the years 2000 and 2010 are 0.6 tons per day.

Based on a control efficiency of 25 to 90 percent, in the years 2000 and 2010, emission reductions are estimated to be 0.4 tons per day.

COST EFFECTIVENESS

The costs for low-NO $_{\rm X}$ burners and flue gas recirculation will vary greatly with the type of combustion unit and its operating schedule. For operating schedules typical of most units, the costs for the use of low-NO $_{\rm X}$ burners and flue gas recirculation range from about \$2,000 to \$6,000 per ton of NO $_{\rm X}$

Based on typical operating schedules, the control costs for SNCR and SCR range from about \$6,000 to over \$22,000 per ton of NO_X reduced.

OTHER IMPACTS

Implementation of this measure is not expected to result in any significant adverse impacts. If SCR or SNCR is used, there may be some ammonia emissions due to chemical slippage.

REFERENCES

California Air Resources Board. 1987. <u>Staff Report for Public Meeting to Consider Approval of a Suggested Control Measure for Controlling Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters. 1987.</u>

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. October 1982.

Statewide Technical Review Group. 1987. <u>Technical Support Document for a Suggested Control Measure for the Control of Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators and Process Heaters</u>. 1987.

CONTROL OF EMISSIONS FROM PETROLEUM REFINERY HEATERS AND BOILERS [NO_x]

SUMMARY

Source Category: Petroleum Refinery Heaters and Boilers

Control Methods: Selective Catalytic Reduction (SCR); Methanol

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 46.9 | 30.2 25.7 | 30.4 25.8 |

Control Cost: \$5,300 to \$14,900 Per Ton Of NO_X

Other Impacts: Potential Increase in Ammonia Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

Refinery heaters and boilers are combustion equipment which are used to transfer heat from combustion gases to water and other fluids for various refinery applications and are likely to be fired with a wide range of refinery by-product fuels, both gaseous and liquid. Refinery heaters and boilers collectively represent a significant source of NO_X emissions in the Air Basin. The associated NO_X emissions are attributed to the burning of fuels in the combustion process (USEPA, 1973).

Regulatory History

Measure A8 of the 1982 AQMP Revision was originally proposed to reduce NO $_{\chi}$ emissions from this source category (SCAQMD, 1982). Refinery heaters and boilers are currently regulated under Rule 1109, which requires these unit processes to meet a refinery-wide NO $_{\chi}$ flue gas concentration limit. The District proposed amendment to Rule 1109 is directed toward further reduction of NO $_{\chi}$ flue gas concentration in petroleum refinery heaters and boiler units. The proposed measure introduced herein is in conjuction with the proposed amended Rule 1109 for this source category. Detailed

description of the proposed measure is contained in the District's staff report on Rule 1109 (SCAQMD, 1987).

PROPOSED METHOD OF CONTROL

This control measure proposes to reduce NO_X emissions through the application of the flue gas treatment technologies in refinery heaters and boilers. Flue gas treatment systems use a reducing agent, usually ammonia, to react with NO_X and reduce it to nitrogen and water. The selective catalytic reduction (SCR) is a flue gas treatment method in which ammonia is first injected into the flue gas stream with a temperature of less than $800^{\circ}F$. The flue gas/ammonia mixture is then passed over a catalyst bed in a reactor vessel reducing NO_X emissions. SCR can achieve a NO_X reduction efficiency of 90 percent or greater.

The use of methanol offers another option for controlling NO_X emissions from refinery heaters and boilers. The emissions reduction potential of methanol fuel use, however, is unknown at this time since demonstration tests have not been conducted on refinery heaters and boilers. Industry may want to consider conducting such tests if initial economic and engineering analysis indicates that methanol fuel use would provide a viable alternative (SCAQMD, 1987).

EMISSIONS REDUCTION

In 1985, refinery heaters and boilers contributed 46.9 tons per day of NO_X in the Air Basin. These emissions are estimated to reach 30.2 and 30.4 tons per day in the years 2000 and 2010, respectively. The decline in emissions is due to the implementation of the current rule 1109. Based on an 85 percent control efficiency, the emissions reductions for this source category are expected to be 25.7 and 25.8 tons per day for the years 2000 and 2010.

COST EFFECTIVENESS

The cost effectiveness of the proposed measure using SCR ranges from about 55,300 to 14,900 per ton of NO_X reduced for individual refineries.

OTHER IMPACTS

Implementation of this measure is not expected to result in any significant adverse impacts. There may be some ammonia emissions due to chemical slippage.

REFERENCES

South Coast Air Quality Management District. 1982. <u>Final Air Quality Management Plan</u>. October 1982.

South Coast Air Quality Management District. 1987. <u>Proposed Amended Rule 1109</u>: <u>Emissions Of Oxides Of Nitrogen From Boilers And Process Heaters In Petroleum Refineries</u>. South Coast Air Quality Management District Staff Report. October 1987.

U.S. Environmental Protection Agency. 1973. <u>Air Pollution Engineering Manual</u>, Second Edition. 1973.

C- COMMERCIAL AND INDUSTRIAL PROCESSES

Table I-2C contains the listing of the control measures proposed to reduce emissions from commercial and industrial processes sources. Detailed description of the control measures for each of these sources are described in the following section.

TABLE I-2C TIER I CONTROL MEASURESCOMMERCIAL AND INDUSTRIAL PROCESSES

| AQMP No. | CONTROL |
|-------------|--|
| C-1 | Control of Emissions from Large Commercial Bakeries, [ROG] |
| C-2 | Control of Emissions from Breweries, [ROG] |
| C-3 | Control of Emissions from Commercial Charbroiling, [ROG,PM] |
| C-4 | Further Emission Reductions from Rubber Products Manufacturing, [ROG, PM] |
| C-5 | Further Emission Reductions from Unconfined Abrasive Blasting Operations, [PM] |
| C-6 | Control of Emissions from Woodworking Operations, [PM] |
| C-7 | Control of Emissions from Small Boilers and Process Heaters, $[\mathrm{NO}_{\mathrm{X}}]$ |
| C-8* | Control of Emissions from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters, [NO _X] |
| C-9* | Control of Emissions from Stationary Gas Turbines, [NO _x] |
| C-10* | Control of Emissions from Electric Power Generating Boilers, [NO _X] |
| C-11 | Control of Emissions from Afterburners, [NO _x] |
| C-12 | Control of Emissions from Non-Utility Internal Combustion Engines, [All Pollutants] |

CONTROL OF EMISSIONS FROM LARGE COMMERCIAL BAKERIES [ROG]

SUMMARY

Source Category: Large Commercial Bakeries

Control Methods: Add-On Controls

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 5.8 | 5. 4 | 5.4 |
| ROG Reduction | | 1.8 | 1.8 |

Control Cost: \$4,400 Per Ton Of ROG

Other Impacts: Possible Negative Effect On The Quality Of Bread; Small Increase In NO, Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

The two most popular yeast-leavened bread making processes are the straight-dough process and the sponge-dough process. In the straight-dough process, all the ingredients are mixed into the dough in a single step. The sponge-dough process requires that a part of the ingredients be mixed and allowed to ferment for three and one half to 5 hours, after which the rest of the ingredients are added. The majority of commercial bakeries uses the sponge-dough process, whereas the straight-dough process is used primarily for homemade breads. Commercial bread production in the Basin is ninety five percent sponge-dough and five percent straight-dough process (Enmann, 1984; Moreland, 1984).

The organic emissions (primarily ethanol) from the sponge-dough process are far greater than those from the straight-dough process. The Bay Area Air Quality Management District extensively researched stack emissions from commercial bakeries. Their work estimated that ROG emissions from large commercial bakeries using the sponge-dough process were 3.8 pounds of ROG per 1,000 pounds of bread produced (BAAQMD, 1987). In 1979, the United States Environmental Protection Agency estimated that emissions from the straight-dough process were only 0.5 pounds of ROG per 1,000 pounds of bread produced (USEPA, 1979). The majority of the emissions are emitted from the ovens during baking - over 75 percent for the straight-dough process and over 99 percent for the sponge-dough process (Price, 1982).

It has been estimated that the District has about 1,740 small, 25 large, and 9 very large commercial bakeries in operation (Price, 1982). In 1985, the total consumption of bakery goods in the Basin was over 436,250 tons (21,812 tons straight-dough and 414,438 tons sponge-dough).

Regulatory History

The statewide Technical Review Group has identified bakeries as a source category for which implementation of a control measure may be appropriate. The South Coast Air Quality Management District has not previously proposed a rule or a control measure directed at bakeries. However, the Bay Area Air Quality Management District currently has a control measure in draft status that would reduce ROG emissions from this source category.

PROPOSED METHOD OF CONTROL

Organic emissions emanating from the ovens can be controlled by the installation of direct-flame or catalytic afterburners. This type of control equipment has been developed for other sources. The Manufacturers of Emissions Control Association maintains that catalytic afterburners could reduce ROG emissions from commercial bakeries (Bertelson, 1986). This equipment has been tested only recently on a bakery in the Bay Area (Yarrington, 1987).

Due to the potential high cost of the control equipment, only very large commercial bakeries (i.e. those producing over 100,000 pounds of bread per day) will be required to reduce ROG emissions.

Alternative methods of control, such as the recirculation of the organic gases back into the flame zone of the oven and the use of an existing broiler as an afterburner, have been researched but have been found technically infeasible or detrimental to the quality of the bread (Cutino, 1987).

EMISSIONS REDUCTION

In 1985, all bakeries emitted 5.8 tons per day of ROG in the Air Basin. In the years 2000 and 2010, it is estimated that emissions will reduce to 5.4 tons per day due to the projected growth factors for this source category. Both direct-fired and catalytic afterburners are considered to be over 90 percent effective at reducing ROG emissions from bakery exhaust (Yarrington, 1987). However, the overall efficiency of the proposed measure to reduce emissions from this source category is 37 percent because

only very large bakeries would be required to reduce ROG emissions. Therefore, implementation of this measure will result in a reduction of about 1.8 tons per day in the years 2000 and 2010.

COST EFFECTIVENESS

The cost of purchasing and installing a thermal incineration system with an air flow of 15,000 cfm, is about \$640,000. The annual operating and maintenance costs amount to \$300,000. Assuming an uncontrolled emission rate of 495 lbs per day and an emissions reduction of 90 percent, The cost effectiveness is approximately \$4,400 per ton of ROG reduced.

OTHER IMPACTS

There may be difficulties in installing the control equipment due to the sensitive nature of the ovens. Since bakery ovens are strictly controlled with respect to temperature, humidity, and pressure, the back pressure caused by the control equipment may have a negative effect on the quality of the bread.

Due to the considerable "downtime" associated with installing the control equipment, it may be necessary to develop a schedule to bring bakeries into compliance.

The operation of direct-fired afterburners results in the emissions of ${\rm NO_X}$ which contributes to the ambient concentrations of ${\rm NO_X}$ and PM and may lead to the formation of ozone. Catalytic afterburners emit less ${\rm NO_X}$.

RFFFRENCES

Bay Area Air Quality Management District. "1982 Bay Area Air Quality Plan". December, 1982.

Cutino, Judy. 1986. Bay Area Air Quality Management District, Personal Communication with Jack Broadbent, June 1986.

Enmann, Joe. 1984. Master Bakers Retail Association of Southern California. Personal Communication with Jack Broadbent, 1984.

Fakhoury, Jim. 1984. Report on Area Source Emissions for C/Y 1983 from Bread Bakeries in the SCAQMD Air Basin. South Coast Air Quality Management District. 1984.

Moreland , Ken. 1984. Bakery Products Club, Los Angeles. Personal Communication with Jack Broadbent, 1984.

Price, Monty. 1982. "Reactive Organic Gases (ROG) Emissions from Bakery Operations in the SCAQMD", Internal Memorandum, South Coast Air Quality Management District. October 1982.

U.S. Environmental Protection Agency. 1979. <u>Compilation of Air Pollutant Emission Factors</u> AP-42, Sec. 6.13.1, Supplement 9. July 1979.

Yarrington, Bob. 1987. Inglehart. Personal Communication with Steve Brunner, August 1987.

CONTROL OF EMISSIONS FROM BREWERIES [ROG]

SUMMARY

Source Category: Breweries

Control Methods: Exhaust Control Technology

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 0.1 | 0.1 | 0.1 |
| ROG Reduction | | 0.05 | 0.05 |

Control Cost: \$20,000 to 96,000 Per Ton Of ROG

Other Impacts: Control Of Odorous Hydrocarbons Beneficial Use

Of Recovered Ethanol From Fermentation

DESCRIPTION OF SOURCE CATEGORY

Background

Beer production in the Basin is limited compared to other areas of the state. There are three major commercial breweries located in the District. These are the "Miller Brewery Company" located in Irwindale, and the "Anheuser-Busch, Inc." and "The Stroh Brewery Company" in Van Nuys. These three breweries combined, produce approximately 18 million barrels of beer per year. In addition to these large breweries, there are four small breweries (less than 60,000 barrels per year) located in Los Angeles County which started operation in the past few years. (Nalley, 1988)

Ethanol and other reactive organic compounds produced during different brewing processes are generally emitted through uncontrolled stacks and vents to the atmosphere. Brewing process begins with mashing (cooking malt flour) followed by separation of mashing extract (wort) in straining tanks called "lauter tun". The wort is then boiled in the brew kettle. Hops are added to the wort during boiling to impart flavor and characteristics of the beer. When boiling is finished, hops are filtered out and the wort is transferred to the fermentors for primary fermentation.

Points of Emissions

In a study of breweries emissions in the state of California, the potential emission sites were reported as brew kettle stacks with over 40 percent of the total emissions, followed by lauter tun stacks (16 percent), activated carbon regeneration (15 percent), and beechwood washers (14 percent). Open fermenters in the small breweries were reported as contributing almost 7 percent of the total VOC emissions from all (4 large and 5 small) breweries in California (ARB, 1983). Small breweries in the Basin have recently started operation and no established data is available for the emissions from small breweries in the Basin.

Emissions from the mashing and lauter tun processes exhaust consist mainly of water vapors, but also contain measurable amounts of volatile organic compounds evolving from the cooking of barley malt. In the brew kettle a large number of undesired Volatile Organic Compounds (VOCs) contained in the hop oils and resins are boiled off to the atmosphere. Brew kettle stacks are the major source of VOC emissions in the breweries.

The primary fermentation process in all large breweries is carried out at low temperature (40 to 55° F) and in closed tanks which enables collection of carbon dioxide (CO₂) for later use. Ethanol and other organic compounds evolved during fermentation are collected along with CO₂ by scrubbing system. CO₂ is then purified by carbon adsorption. The activated carbon bed releases adsorbed VOC impurities during bed generation directly into the atmosphere. Small breweries carry out fermentation in open tanks and emissions are vented to the atmosphere. Emissions from hot water wash tanks in the recycling of the beechwood chips used in secondary fermentation are also vented to the atmosphere.

Regulatory History

The District has no specific rules concerning ethanol and other volatile organic compound emissions from breweries. Currently, the emissions from this source category may be limited only under Rule 402 which limits the discharge from any source causing nuisance to the public. The proposed control measure is directed toward the emission control of ethanol and other organic compounds from brewing processes.

PROPOSED METHOD OF CONTROL

The proposed control method to reduce ROG emissions from this source category is to require exhaust control technology be applied to the most important processes which are responsible for the highest percentage of the brewing emissions, the brew kettles and the fermentation rooms, at large and small breweries, respectively.

Control of Brew Kettle Emissions

Brew kettles emissions consist of a variaty of volatile organic compounds. The most desirable method proposed for this measure would be activated carbon systems. Activated carbon filters can be placed at the top of brew kettle stack to capture the vapor organic contaminants before they escape to the atmosphere. Spent carbon beds need to be regenerated or disposed of in approved waste disposal sites. Carbon adsorption devices, in general, have shown to have a control efficiency of 90 percent or greater to reduce ROG emissions from other types of exhausts such as winary fermentation tanks (ARB, 1987). These control methods have not been installed on brew kettle stacks in breweries; however, it is expected that similar control efficiencies could be acheived for this type of application.

Since most of the VOCs in the brew kettle stacks are barely soluble or insoluble in water, water-based scrubber system would not be practical. Use of organic solvent as the scrubbing medium may be applicable if economically feasible. Condensation of brew kettle stack exhaust gas is another control method in which the exhaust gases condense as they flow through a surface condenser unit. The effectiveness of this control method requires further investigation.

Control of Fermentation Room Emissions

Emissions from the fermentation rooms at small breweries mainly consist of ethanol. The control point would generally be the roof vent where emissions from individual fermenting tanks are channeled. The proposed control method for these emissions would be carbon adsorption. Since substantial adsorbate (ethanol) recovery is possible, carbon adsorption is the most cost effective method to control fermentation room exhaust. Although ethanol is highly soluble in water, ethanol concentration in the exhaust stream are too low for absorption (by water scrubbing) to be practical.

EMISSIONS REDUCTION

Emissions from breweries were estimated to account for approximately 0.1 tons per day of ROG in 1985. The ROG emissions in the years 2000 and 2010 are expected to remain the same. Control devices proposed in this measure are generally more than 90 percent efficient in the removal of ROG emissions. The overall control efficiency for this category is about 40 percent, therefore, implementation of this measure can achieve an emissions reduction of approximately 0.05 tons per day of ROG in the years 2000 and 2010.

COST EFFECTIVENESS

Implementation of the proposed requirements would impose a cost impact on large and small breweries in the Basin. The cost effectiveness of carbon adsorption as the control measure in large breweries with an average brew

kettle stack of 5,000 cfm is estimated to be approximately \$96,000 per ton of ROG reduced. The cost effectiveness of carbon adsorption for small breweries with an average fermentation room exhaust flow of 800 cfm, and with the credit for recovered ethanol is estimated to be \$20,000 per ton of ROG removed.

OTHER IMPACTS

The proposed measure will likely minimize the odor complaints from breweries. Recovered ethanol from fermentation tanks, adsorbed by activated carbon, can be used for sale or re-use.

REFERENCES

California Air Resources Board. 1987. <u>Public Meeting to Consider Approval of Suggested Control Measure For Emissions From Winary Fermentation Tanks</u>. California Air Resources Board Staff Report, Sacramento. January 1987.

California Air Resources Board. 1983. <u>Characterization of Fermentation Emissions From California Breweries</u>. Submitted by Science Applications, Inc.Los Angeles. October 1983.

Nalley, Jim. 1988. Federal Bureau of Alcohol and Tobacco. Personal communication with S. Cohanim, February 1988.

CONTROL OF EMISSIONS FROM COMMERCIAL CHARBROILING [ROG, PM]

SUMMARY

Source Category: Commercial Charbroiling

Control Methods: Exhaust Control Technology; Grill Design Changes

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 1.9 | 2.5 2.3 | 2.8 2.5 |
| PM Inventory PM Reduction | 7.4 | 10.1 9.1 | 11.2 10.1 |

\$25,000 Per Ton of ROG Control Cost:

\$6,200 Per Ton of PM

Other Impacts: Reduced Fire Hazards; Reduced NO $_{\chi}$, SO $_{\chi}$, CO $_{2}$,

And CO Emissions; Energy Saving's

DESCRIPTION OF SOURCE CATEGORY

Background

Charbroiling is the most common method of direct meat-firing by fast-food and full service restaurants. Charbroilers consist of three main components: a heating source, a high temperature radiant surface, and a grill. The grill, which is grated, holds the meat while exposing it to the radiant heat. When grease from cooking meat falls onto the high temperature radiant surface, both reactive organic gas and particulate emissions occur. Approximately 93 percent of the particulate matter is less than 1 micron, and virtually all of it is less than 10 microns (Bornstein, 1977). The charbroiler can be located either against the wall where the exhaust flows to a wall-mounted hood, or in the middle of the kitchen where the exhaust flows to an island-type hood.

Approximately 2,500 restaurants and fast-food establishments in the South Coast Air Basin employ charbroilers to cook steaks, hamburger patties, chicken, and other foods (SCAQMD, 1985). Restaurants normally operate flame-fired broilers during the dinner hours of 6 PM to 8 PM only. However, many fast-food establishments have direct-flame patty broilers with peak operations from 11 AM to 2 PM and from 5 PM to 9 PM.

Regulatory History

ROG and particulate emissions from commercial charbroiling operations are largely uncontrolled. Although establishments that employ charbroilers must comply with District standards for opacity, nuisance, and odor, they are exempt from Rule 203 which requires permits to operate equipment that releases air contaminants.

However, these establishments must comply with state requirements which usually follow the standards set forth by the Building Officials and Code Administration's <u>Basic Mechanical Code</u> and the National Fire Protection Agency's <u>National Fire Codes</u>. These codes require charbroiling facilities to operate and maintain sufficient grease removal devices and exhaust and ventilation systems. Such controls reduce grease particulate emissions by between 60 percent and 90 percent (Bornstein, 1977).

PROPOSED METHOD OF CONTROL

Several technologies are available to reduce emissions from commercial charbroilers. Using a combination of options (1) through (3) or option 4 alone, as outlined below, emissions can be reduced by up to 90 percent or more. Outlined below are the regulatory proposals for the control options:

- o Require charbroiling facilities to utilize grease extracting exhaust hoods that are at least 95 percent efficient.
- Require the installation of an electrostatic precipitator downstream from the exhaust hood with a minimum collection efficency of 90 percent. This will further reduce grease particle emissions while curbing smoke particle emissions as well. (For wall-mounted hoods the grease extractor and precipitator can be integrated into one unit).
- Require an additional control device downstream from the precipitator (whether the precipitator is free-standing or part of a combined grease extractor/precipitator device) which will reduce ROG emissions. This device can take the form of either an adsorption filter system or an afterburner with a minimum ROG destruction efficiency of 95 percent.
- Encourage facilities to replace existing charbroilers with grooved griddles. Although these griddles cannot be a substitute for all methods of patty broiling (e.g. Burger King uses a conveyor-type flame broiler), they impart a similar appearance and flavor on the

hamburger patties. Athough the emission reductions for these griddles are unknown at this time, a representative of Wolfe Range Company claims that they prevent 100 percent of the dripping fat from being burned (Halliburton, 1987). Emission confirmation testing of these griddles should be carried out to further clarify the emission reduction potential of their use.

EMISSIONS REDUCTION

In 1985, charbroiling facilities in the Basin emitted approximately 1.9 tons per day of ROG and 7.4 tons per day of PM. It is estimated that in the year 2000, emissions from this source category will reach approximately 2.5 tons per day of ROG and 10.1 tons per day of PM; by the year 2010, emissions will be approximately 2.8 tons per day of ROG and 11.2 tons per day of PM.

The add-on exhaust control technology proposed above is estimated to be 90 percent efficient in reducing ROG and PM emissions. This would provide an emissions reduction of 2.3 tons per day of ROG and 9.1 tons per day of PM by the year 2000 and 2.5 tons per day of ROG and 10.1 tons per day of PM by the year 2010. Although the control efficiency for the use of a grooved griddle is unknown at this time, this alternative may also reduce emissions significantly.

COST EFFECTIVENESS

Assuming a 90 percent control efficiency, the cost effectiveness for this measure consisting of an efficient grease extractor, an electrostatic precipitator and a filter system, is about \$25,000 per ton of ROG reduced and \$6,200 per ton of PM reduced.

OTHER IMPACTS

An efficient, self-cleaning system would reduce fire hazards caused by grease build-up in the exhaust system. Additionally, labor cost savings would occur since the exhaust ducts would not have to be cleaned as often as current systems.

Since a large proportion (89 percent) of the charbroilers in the Basin are natural gas fired, they emit small amounts of uncontrolled NO χ , SO $_\chi$, CO $_2$, and CO (Bornstein, 1977; Vasan, 1987). The proposed add-on controls would reduce these emissions by approximately 90 percent as well.

Additionally, since grooved griddles are thermostatically controlled and require less ventilation, they would save on energy costs (Halliburton, 1987).

REFERENCES

Bornstein, Mark I. 1977. <u>Study to Develop Background Information for the Direct Meat-firing Industry</u>. GCA Corporation, Bedford, MA. 1977.

Ross, Paul A. 1987. Wolfe Range Co. Personal Communication with Ranji George, 1987.

South Coast Air Quality Management District. 1985. <u>Area Source Emissions From Commercial Charbroiling in the Food and Kindred Sector</u>. Engineering Division Staff Report.

Vasan, L. 1987. Wolfe Range Co. Personal Communication with Steve Brunner, 1987.

FURTHER EMISSION REDUCTIONS FROM RUBBER PRODUCTS MANUFACTURING [ROG, PM]

SUMMARY

Source Category: Rubber Products Manufacturing

Control Methods: Collection System with Electrostatic Precipitator

Connected to a Ductwork System Before a Carbon

Adsorber

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 11.2 | 14.7 11.1 | 15.6 11.7 |
| PM Inventory PM Reduction | 0.8 | 0.9 0.7 | 1.0 0.7 |

Control Cost: \$5,600 Per Ton of ROG

\$2,500 Per Ton of PM

DESCRIPTION OF SOURCE CATEGORY

Background

The typical rubber product manufacturing operation consists of: 1) mixing and compounding rubber with certain additives such as vulcanizing agents (sulfur), fillers (carbon black, zinc oxide), softeners (organic oils), antioxidants (phenols or amines), accelerators and retardants of vulcanization (thiazoles, carbamates or amines) and others; and 2) manufacturing sequent curing, if necessary. Hot processes include molding where shaping and vulcanization take place simultaneously. Cold processes involve mostly extrusion or calendering where the desired products are first shaped and then are cured in curing ovens or autoclaves where vulcanization occurs.

Field observations showed that most of the solid particulate emissions are adequately controlled in mixing and calendering processes by the use of hoods and baghouses. Fugitive emissions (solid particulates) occur, however, in the extrusion process when rubber tubing is passed through the open batch of talc.

Additional fugitive emissions are observed also in molding and curing processes when vulcanized rubber products are taken out of curing ovens or presses. Such emissions probably consist of decomposition products or organic additives or reaction products formed in the vulcanization process. These products exist as visible liquid particulates (aerosols) and are mostly uncontrolled.

Regulatory History

Measure D7 of the 1982 AQMP Revision proposed PM reductions from the rubber products manufacturing industry. No implementation action has been taken or is expected to occur prior to adoption of this AQMP Revision. Therefore, measure D7 is reintroduced herein.

PROPOSED METHOD OF CONTROL

ROG and PM emissions can be reduced by at least 95 percent by using a single-pass collection system which incorporates an electrostatic precipitator (ESP) and carbon adsorber. Ductwork is also necessary to reduce the temperature of the effluent before entering the ESP, otherwise, the vapor emissions to be controlled of high boiling organics, such as oils and fatty acids, would likely be above the dew point needed to condense such vapors. Once the vapors are condensed, the electrostatic precipitator will provide adequate collection efficiency. It may be possible to increase the PM control efficiency by using a double pass system in which the second unit reduces the particulates remaining from the first unit by another 95 percent.

Since the precipitator only collects condensable organic emissions in the form of aerosols, a carbon adsorber may be connected after the precipitator to collect the non-condensable organic material. The ESP, which is installed before the carbon adsorber, serves as a pre-treater to remove the particulates from the effluent to avoid plugging of the pores of the carbon bed.

The fugitive emissions, both in particulate and gaseous forms, can be reduced by means of pick-ups installed in appropriate locations in the processing areas.

EMISSIONS REDUCTION

The 1985 ROG and PM emissions from rubber product manufacturing were about 11.2 tons per day and 0.8 tons per day, respectively. ROG and PM emissions

from this source category are expected to be 14.7 tons per day and 0.9 tons per day in the year 2000, and 15.6 tons per day and 1.0 tons per day in the year 2010, respectively. Assuming that 80 percent of these emissions are captured and controlled by 95 percent, the emissions reductions are estimated to be 11.0 tons per day of ROG and 0.7 tons per day of PM in the year 2000. Comparative emissions reduction for the year 2010 are expected to be 11.7 tons per day of ROG and 0.7 tons per day of PM.

COST EFFECTIVENESS

To control PM emissions, a double bypass electrostatic preciptator (ESP) will be needed. The cost of purchasing and installing a system with an air inflow rate of 5,000 cfm is about \$70,000. The annual operating costs amount to \$11,400. Assuming an overall emissions reduction of 75 percent, the cost effectiveness is \$2,500 per ton PM reduced.

To control ROG emissions, an on-site carbon adsorption system will be needed. The cost of purchasing and installing a system, with an air inflow rate of 5,000 cfm, is about \$148,000. The annual operating costs amount to \$40,000. Assuming an overall emissions reduction of 75 percent, the cost effectiveness is \$5,600 per ton ROG reduced.

OTHER IMPACTS

Regeneration of the carbon adsorber may result in generation of liquid hazardous wastes. The collected particulate matters need to be disposed of in approved landfills.

REFERENCES

Krause, Paul. 1987. Personal Communication with Linda Basilio, 1987.

South Coast Air Quality Management District. 1983. <u>Proposed Rule 1142</u>, <u>Rubber Products Manufacturing</u>. South Coast Air Quality Management District Staff Report. February 1983.

South Coast Air Quality Management District. 1980. <u>Tactic P-4 Write-Up.</u> 1980.

U.S.Environmental Protection Agency. 1979. <u>Guidance for LAER from 18 major stationary sources of particulates</u>, nitrogen oxides, sulfur dioxide or VOC, (EPA-450/3-79-024). 1979.

FURTHER EMISSION REDUCTIONS FROM UNCONFINED ABRASIVE BLASTING OPERATIONS [PM]

<u>SUMMARY</u>

Source Category: Abrasive Blasting

Control Method: Tighter Standards On Abrasive Materials;

Removal of Opacity Standard Exemption For

Abrasive Blasting From Rule 401

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| PM Inventory | 3.9 | 4.6 | 4.8 |
| PM Reduction | | 2.3 | 2.4 |

Control Cost: \$37,800 Per Ton Of PM

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

Abrasive blasting is the cleaning or preparing of a surface by forcibly propelling a stream of abrasive material against the surface. It is employed in countless industrial and commercial applications. Unconfined abrasive blasting does not use any enclosure (shrouding, tank, drydock, building, structure) to control particulate emissions. Abrasives include sand, slag, steel shot, and other materials.

Unconfined abrasive blasting occurs at many locations throughout the District. The purpose of this blasting is to remove old paints and coatings, to prepare the surface for a new coating, to remove rust, and to make other preparations. Much of this blasting takes place in the harbor area and in the south Los Angeles area. Although it is less commonly used than confined blasting, the overall emissions from unconfined blasting are greater than those of confined blasting.

Regulatory History

Abrasive blasting is currently regulated by Rule 1140, which allows abrasive blasting to be unconfined when: (a) steel or iron shot/grit is used; (b) the item to be abrasive blasted exceeds 8 feet in height or width, or 10 feet in length; or (c) the structure or surface is abrasively blasted at its permanent or ordinary location. In lieu of this, the rule specifies requirements on the abrasives that can be used for dry unconfined blasting.

One requirement is that before blasting the abrasive shall not contain more than 1 percent by weight of material passing a No. 70 U.S. Standard sieve. Another requirement is that after blasting the abrasive shall not contain more than 1.8 percent by weight of material 5 microns or smaller. Certified abrasives reused for dry unconfined blasting are exempt from the latter requirement.

Under the operating requirements of Rule 1140, emissions from abrasive blasting are not allowed to exceed a darkness shade of No. 2 (as designated on the Ringelmann Chart of the U.S. Bureau of Mines), or an opacity of 40 percent. The District's general opacity rule (Rule 401) limits the opacity of visible emissions to 20 percent, but grants an exemption for abrasive blasting.

PROPOSED METHOD OF CONTROL

PM emissions can be reduced from unconfined abrasive blasting by tightening the requirements for abrasive materials, and by deleting the visible-emission exemption from Rule 401. Regulatory proposals for each of these controls are outlined below.

Abrasives

- o Require that the amount of material passing through a No. 70 sieve to be limited to no more than 0.5 percent.
- o Require that, after blasting, the abrasive material shall not contain more than 1.0 percent by weight of material 10 microns or smaller.
- Remove any "after blasting" exemption provided to certified abrasives reused for dry unconfined blasting.

Opacity

- o Remove from Rule 401 the exemption provided to abrasive blasting operations.
- o Require abrasive blasting operations to limit all air-contaminant discharges to an opacity of 20 percent (or a darkness shade of No. 1 on the Ringelmann Chart).

EMISSIONS REDUCTION

The emissions inventory and reduction mentioned in this section pertain to all abrasive blasting operations including both confined and unconfined processes. In 1985, approximately 3.9 tons per day of PM were emitted from abrasive blasting. In the years 2000 and 2010, it is estimated that emissions will grow to 4.6 and 4.8 tons per day, respectively. The above requirements are estimated to reduce PM emissions by approximately 50 percent. Such a program will result in a reduction of 2.3 tons per day in the year 2000 and 2.4 tons per day in the year 2010.

COST-EFFECTIVENESS

At a site, the capital cost of purchasing and installing an enclosure and a baghouse (to comply with the opacity repuirements proposed) is \$20,000. The annual cost of operating this control equipment is \$1,116. Assuming a reduction of 1200 lbs over the life of the equipment, about 3 years, the cost effectiveness becomes \$37,800 per ton of PM reduced.

OTHER IMPACTS

Implementation of the proposed control measure is not expected to result in any adverse effects.

REFERENCES

South Coast Air Quality Management District. 1985. Rules and Regulations, Rule 1140, Adopted February 1, 1980; Amended August 2. 1985.

CONTROL OF EMISSIONS FROM WOODWORKING OPERATIONS [PM]

SUMMARY

Source Category: Woodworking Operation

Control Methods: Exhaust Control Technology

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| PM Inventory | 24.0 | 36.0 | 37.0 |
| PM Reduction | | 34.0 | 35.0 |

Control Cost: \$12,000 Per Ton Of PM

Other Impacts: Beneficial Use Of Collected Fine Wood Dust And

DESCRIPTION OF SOURCE CATEGORY

Background

There are approximately 3700 facilities estimated to be located in the Air Basin where woodworking is undertaken such as lumber yards, wood turning and carving shops, and furniture and other product manufacturing facilities. Common woodworking operations include sawing, planing, facilities, and sanding. Each of these operations generate small wood waste particles in the form of shavings, sawdust, and fine wood dust.

Most woodworking plants employ pneumatic conveying systems that remove the generated wood waste from immediate area of each operation and transport this waste to a collection device. These systems are necessary as a housekeeping measure and a convenient method of collecting the waste material for ultimate disposal. Cyclones have historically been the primary means of separating the waste material from the airstream in these pneumatic transfer systems. Although suitable for medium-sized particulate (15 to 40 microns), wood dust particles within 0 to 10 micron size range (PM $_{10}$) are too fine to be effectively collected by the cyclone collectors.

The pollutant of concern in woodworking operations is fine particulate matter. Most fugitive emissions are collected by the cyclone collectors utilized in the pneumatic transfer systems. The quantity of fine particulates escaping from a given cyclone depends on the dimension of the cyclone, the velocity of the airstream, and the type of the woodworking operation. Typical cyclone collectors found in the woodworking industry are about 80 percent efficient in the removal of particles in the 20 to 44 micron size range (EPA, 1980).

Woodworking operations were estimated to contribute approximately 30 tons per day of particulate matter. Information concerning size characteristics is very limited, and it is unknown what fraction of these emissions are within the 0 to 10 micron size range. In a study on exhaust emissions from average wood resawing and wood sanding operations, 56 percent mass fraction of less than 2.1 microns has been reported (Gray, 1986). When evaluating particulate emissions, the waste handling cyclones are considered as the source point.

In addition to the health effects of fine particulates, deposits of fine wood dust particles, on the roof and in the surrounding area of woodworking operations are a common source of public nuisance and complaints in the District. Baghouses have recently been installed as the control device in some large woodworking plants in the Basin. Baghouses collect essentially all sizes of the wood dust particles in the airstream and when employed can significantly improve the emission reduction of PM particles from this source category.

Regulatory History

At present, the District does not have a source specific rule directed at woodworking operations. Most of the cyclone collectors at woodworking facilities are exempt from the District permit system. The emissions from these operations are currently regulated under the District Rules 404 and 405 (for permitted equipments) and Rules 401, 402, and 403.

Rules 404 and 405 regulate the particulate matter emissions from control exhausts based on concentration (volume discharged) and weight criteria, respectively. Rule 401 is to control visible emissions of any air contaminant discharged into the atmosphere from any single source. Rule 402 limits the discharge from any source causing nuisance to the public. Rule 403 is to control fugitive dust in general and is directed toward any control measure is directed toward the emission control of wood dust

PROPOSED METHOD OF CONTROL

The control method proposed herein is to require that fine wood dust material be ducted to more efficient control devices. Although baghouses are recommended to be applied to this type of exhaust, other methods

discussed below may be considered for specific types of operations. A typical woodworking exhaust system consists of a hood for the pickup of wood dust and chips at the operation stations, ductwork, a collection device, a storage bin, and a fan blower. Most of the existing plants employ cyclone collector(s) which utilize pneumatic transfer systems. Any of the proposed high efficiency control devices can be employed as the final collector, and may be used with or without a cyclone collector at the upstream.

Baghouses (Fabric Filter Collectors)

Fabric filters remove particulates by interception, impaction, and diffusion mechanisms. The fabric is usually made into bags of envelope (flat) configurations. The entire structure housing the bags is called a baghouse. Well designed, adequately sized, and properly operated baghouse can be expected to operate at an efficiency in excess of 99 percent on a weight basis (ACGIH, 1982). The collection efficiency for particulates of 1 micron or less may exceed 90 percent (EPA, 1973).

Once the fabric or filter mat accumulates a dust cake, further collection is accomplished by sieving as well as by the previously mentioned mechanisms and the combined mass becomes increasingly efficient. At the same time, the resistance to airflow increases. In a well designed fabric collector system the filter mat should be cleaned or reconditioned before the airflow is reduced below the acceptable level.

Baghouse filters can be cleaned (reconditioned) periodically (intermittent bag shaking) or continiousely (reverse-pulse cleaning). In some larger sources with heavy concentration of wood waste, lower efficiency collector devices such as cyclones may be required to be installed upstream to remove the bulk of entrained particles before final filtering in a baghouse. Careful thought should be given to unloading collected dry wood particles for ultimate disposal to avoid secondary wood dust problem from storage bins.

Other Methods Of Control Devices

Electrostatic Precipitators (ESP's) collect particles by establishing electric field between discharge and collecting electrodes. A survey of manufacturers indicates that due to the low charge, low velocity, and combustible nature of wood waste particles this method is not suitable for woodworking operations. There are no established data concerning the efficiency of ESP's in the woodworking operations. Efficiencies of 90 to 95 percent for the removal of PM particles have been reported for other types of industrial processes (EPA, 1973). Application of this control method requires further investigation.

Wet Collectors could be applied to handle moisture-laden fine dusts such as wood sanding flour particles. For well designed equipment, the efficiency depends on the energy input per cubic feet per minute (cfm) of air. Wet collectors are 94 to 98 percent efficient in removing fine particles

(ACGIH, 1982). Although the collection of fine sawdust particles in wetted form eliminates secondary dust problems, disposal of wet sludge can generate a material handling problem.

EMISSIONS REDUCTION

In 1985, woodworking operations emitted 24.0 tons per day of PM in the Air Basin. It is estimated that PM emissions from this source category will reach approximately 36.0 tons per day and 37.0 tons per day in the years 2000 and 2010, respectively. The control devices proposed in this measure are generally 95 percent efficient in removal of particulate matter as small as 0.1 microns. Implementation of this measure can provide emission reductions of 34.0 tons per day in the year 2000 and 35.0 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed measure would impose a cost impact on woodworking facilities in the Basin. Factors effecting equipment cost include capacity, accessories, installation, and special construction. A survey of manufacturers indicates that for average woodworking operations with 2,000 to 7,500 cfm capacity, the baghouse including filters and fans will cost from \$7,000 to \$15,500. Based on an average capacity of 5,000 cfm and control efficiency of 95 percent, the cost effectiveness of this measure is estimated to be \$12,000 per ton of PM reduced.

OTHER IMPACTS

The proposed actions will likely minimize public nuisance situations and complaints concerning wood dust emissions from woodworking operations. Emissions from storage bins can create a secondary sawdust problem where careful thought is not given to unloading collected wood particles for ultimate disposal. The use of waste wood material collected, to make other products such as particle board, plastic wood, fire wood, and soil additive can minimize the waste disposal problem.

REFERENCES

American Conference of Governmental Industrial Hygienists. 1982. <u>Industrial Ventilation</u> (17th Edition). 1982.

Gary, Harry A. 1986. <u>Control of Atmospheric Fine Primary Carbon Particle Concentrations</u>. California Institute of Technology, Pasadena. February

- South Coast Air Quality Management District. 1985. "Area Source Emissions From Woodworking Operations In The Wood Processing Sector For C/Y 1983". Engineering Division Report. April 1985.
- U.S. Environmental Protection Agancy. 1973. <u>Air Pollution Engineering Manual</u> (second Edition). Danielson, John A, ed. May 1973.
- U.S. Environmental Protection Agancy. 1980. <u>Compilation of Air Pollutant</u> Emission Factors. February 1980.
- U.S. Department of Commerce. 1985. <u>County Business Patterns</u>. Bureau of Census. Washington D.C. 1985.

CONTROLS OF EMISSIONS FROM SMALL BOILERS AND PROCESS HEATERS [NOx]

<u>SUMMARY</u>

Source Category: Small Boilers And Process Heaters (Less Than 5

MMBTU/Hr)

Control Methods: Use Of Radiant Burner; Methanol; Other

Comparable Control Technologies

Emissions: $(Tons/Day) \qquad \qquad \underline{Year\ 1985} \qquad \underline{Year\ 2000} \qquad \underline{Year\ 2010}$ $NO_X \ Inventory \qquad 2.8 \qquad \qquad 3.2 \qquad \qquad 3.4 \\ NO_X \ Reduction \qquad --- \qquad \qquad 2.4 \qquad \qquad 2.6$

Control Cost: \$8,000 to \$24,000 Per Ton of NOx

Other Impacts: Increase In Gaseous Fuel Usage; Noise Reduction;

DESCRIPTION OF SOURCE CATEGORY

Background

Small boilers and process heaters are used for a wide variety of process heat and steam generation purposes. There are an estimated 24,000 boilers and process heaters less than 5 MMBTU/Hr in the South Coast Air Basin (Gardetta, 1988). These units use gas and/or oil as their primary fuels. Emissions from this source category are mainly oxides of nitrogen along with CO and HC. The associated NO $_{\rm X}$ emissions are attributed from direct combustion of these fuels over a suspended flame mechanism. The uncontrolled NO $_{\rm X}$ emission is about 0.1 pound per million BTU.

Regulatory History

The District requires permits for all oil fired and dual fueled boilers and process heaters of any size. The natural gas fueled units over 20 MMBTU are also under the District's permitting system.

The Proposed Rule 1146, currently under development, will regulate boilers and process heaters with heat input of 5 MMBTU/Hr and greater (SCAQMD, 1987).

The subject proposed method of control will result in the regulation of the remaining boilers and heaters less than 5 MMBTU/Hr and will thus bring them under the District's permitting system.

PROPOSED METHOD OF CONTROL

This control measure proposes to reduce NO_X emissions through the application of radiant burners in small boilers and process heaters. The radiant burner has been demonstrated to be potentially capable of reducing NO_X emissions by up to 75 percent based on the performance of current installations and information provided by burner and boiler manufacturers (Krill, 1988).

The radiant burner uses a porous surface of vacuum formed ceramic fiber to burn pre-mixed fuel gas and air. It is distinguished from a conventional burner by not utilizing a suspended flame. Combustion occurs flamelessly within a very thin layer along the surface of the burner at a temperature of 1850°F , resulting in a totally uniform heat flux to the boiler firetube in the form of thermal radiation. The high percentage of radiant energy transfer results in higher heat transfer efficiency and, therefore, higher overall boiler efficiency. Due to high combustion efficiency and low and uniform operating temperatures ($1800-1850^{\circ}\text{F}$) of the ceramic fiber burner, NO_x emissions of 10 to 20 ppm with only 10 percent excess air can be achieved, a reduction of about 75 percent in comparison with a conventional burner. There would be minimal impact on HC and CO emissions.

The burner is commercially available for both new and retrofit installations up to 10 MMBTU/Hr heat input. It occupies approximately the same physical space as a conventional flame burner, is available in a variety of shapes such as cylindrical and flat plate, and can also be custom made. The radiant burner can only use gaseous fuel: natural gas, propane or LPG (Krill, 1988).

The use of methanol may offer another option for controlling NO_{X} emissions from boilers and process heaters. The emissions reduction for methanol can potentially be equivalent to that of a radiant burner, based on previous demonstration on boilers and turbines. Future field applications can verify the control efficiency for methanol.

Other control technologies involving advanced boiler design, combustion modification and stack gas treatment techniques with equivalent or better level of emission reduction, are also applicable to this source category. It would be the equipment owner's prerogative to choose the best available control technology including, but not limited to, radiant burners to reduce NO_{X} emissions.

FMISSIONS REDUCTION

During 1985, small boilers and process heaters (less than 5 MMBtu) emitted about 2.8 tons per day of NO_{X} . In the years 2000 and 2010, NO_{X} emissions from this source category are expected to be 3.2 tons per day and 3.4 tons per day, respectively. It is estimated that implementation of this measure will reduce emissions from these units by 75 percent. Therefore, the emission reductions are expected to be 2.4 tons per day in the year 2000 and 2.6 tons per day in the year 2010.

COST EFFECTIVENESS

Implementation of the proposed control measure, namely, radiant burners in small boilers and process heaters would have a cost impact on equipment owners in the Basin. The cost of purchasing and installing radiant burners varies from \$10,000 for a 0.5 MMBTU/Hr per hour boiler to \$18,000 for a 5 MMBTU/Hr per hour boiler. This can be somewhat offset by annual natural gas savings generated by higher boiler efficiency. For a 5 MMBTU per hour boiler, these savings amount to \$700 per year. The cost effectiveness of using radiant burners varies from \$8,000 per ton of $\rm NO_X$ reduced for larger boilers to 24,000 per ton $\rm NO_X$ reduced for smaller boilers.

OTHER IMPACTS

Due to the absence of flame, there will be a significant noise reduction. There will also be an increase in the usage of gaseous fuels since radiant burners can only use this type of fuel. Implementation of the proposed measure will also result in additional workload on the District due to permit processing.

REFERENCES

Krill, Wayne. 1988. Alzeta Corp. Personal communication with Zorik Pirveysian, February 1988.

Riethmuller, Jack M. 1988. York Shipley Corp. Personal communication with Zorik Pirveysian, February 1988.

Gardetta, G.M. 1988. Southern California Gas Company. Letter to Pamela Perryman, January 1988.

South Coast Air Quality Management District. 1987. <u>Proposed Rule 1146.</u> <u>Emissions of Oxides of Nitrogen from Industrial Boilers, Steam Generators and Process Heaters.</u> South Coast Air Quality Management District Staff Report. October 1987.

CONTROL OF EMISSIONS FROM INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL BOILERS, STEAM GENERATORS, AND PROCESS HEATERS [NO_X]

SUMMARY

Source Category: Industrial, Institutional, and Commercial Boilers,

Steam Generators, and Process Heaters

Control Methods: Oxygen Control Systems; Low NO_X Burners;

Flue Gas Recirculation (FGR); Selective Non-Catalytic Reduction (SNCR); Selective Catalytic Reduction (SCR); Alternaive Fuels

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| NO _x Inventory | 10.8 | 12.2 | 13.01 |
| NO _v Reduction | | 8.3 | 8.9 |

Control Cost: \$6,800 to \$21,400 Per Ton Of NOX

Other Impacts: Potential Increase in Ammonia Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

Industrial, institutional, and commercial boilers and steam generators are combustion equipment which are used to transfer heat from combustion gases to water to generate steam required for various applications. Boilers consist essentially of one or more burners, a firebox, heat exchanger, and auxiliary systems. Process heaters are also combustion equipment which transfer heat from combustion gases to water or other fluids. The primary fuel used in this source category is natural gas and/or oil (USEPA, 1973).

Regulatory History

Measure G11 of the 1982 AQMP Revision was originally proposed to reduce ${
m NO}_{
m X}$ emissions from this source category (SCAQMD, 1982). The proposed Rule 1146, currently under development, is directed toward reduction of ${
m NO}_{
m X}$ emissions from industrial, institutional and commercial boilers, process heaters, and

steam generators. The proposed control measure is introduced in conjuction with the proposed Rule 1146 for this source category. Detailed description of the proposed measure is contained in the District's staff report on the proposed rule (SCAQMD, 1987).

PROPOSED METHOD OF CONTROL

This control measure proposes to reduce NO_X emissions to 40 PPMVD per 3 percent through the application of controls for this source category. The NO_X emission control technologies are essentially divided into two major categories: combustion modification and flue gas treatment.

The combustion modification methods can achieve NO_χ emissions reduction either by reducing the temperature of combustion or reducing the amount of oxygen available for combustion. These methods include oxygen control systems, low- NO_χ burners, and flue gas recirculation (FGR). Oxygen control systems can be utilized to reduce excess combustion air and thus lowering NO_χ flue gas concentration. Low NO_χ burners use a combination of fuel rich mixtures and staged combustion to reduce NO_χ flue gas concentration. In the FGR method, flue gas is mixed with combustion air, which lowers the flame temperature and combustion temperature, thus reducing thermal NO_χ formation.

Flue gas treatment systems use a reducing agent, usually ammonia, to react with NO $_{\rm X}$ and reduce it to nitrogen and water. There are basically two types of flue gas treatment technologies: selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR). In the SNCR method, ammonia is directly injected into the flue gas stream at around 1600°F , which results in overall reduction of NO $_{\rm X}$ emissions. In the SCR method, ammonia is first injected into the flue gas stream with a temperature of less than $800^{\circ}{\rm F}$. The flue gas/ammonia mixture is then passed over a catalyst bed in a reactor vessel reducing NO $_{\rm X}$ emissions.

The use of methanol offers an additional option for controlling NO_{χ} emissions from this source category. There are currently limited data available on the efficiency of methanol in industrial/commercial boilers, steam generators, and process heaters. Based on demostration projects on utility boilers and gas turbines, similar emission reductions can be expected for the above equipment. Further studies can verify the performance of methanol in these units.

EMISSIONS REDUCTION

In 1985, industrial, institutional, and commercial boilers, steam generators, and process heaters contributed to 10.8 tons per day of NO_{χ} in the Basin. These emissions are estimated to reach 12.2 and 13.1 tons per day in the years 2000 and 2010, respectively. The emissions reductions for this source category are expected to be 8.3 and 8.9 tons per day for the years 2000 and 2010.

CONTROL OF EMISSIONS FROM INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL BOILERS, STEAM GENERATORS, AND PROCESS HEATERS [NO.]

SUMMARY

Industrial, Institutional, and Commercial Boilers, Source Category:

Steam Generators, and Process Heaters

Control Methods:

Oxygen Control Systems; Low NO $_{\rm X}$ Burners; Flue Gas Recirculation (FGR); Selective Non-Catalytic Reduction (SNCR); Selective Catalytic Reduction (SCR); Alternaive Fuels

| Emissions: (Tons/Day) | <u>Year 1985</u> | Year 2000 | <u>Year 2010</u> |
|---------------------------|------------------|-----------|------------------|
| NO _X Inventory | 10.8 | 12.2 | 13.01 |
| NO _X Reduction | | 8.3 | 8.9 |

Control Cost: \$6,800 to \$21,400 Per Ton Of NOx

Other Impacts: Potential Increase in Ammonia Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

Industrial, institutional, and commercial boilers and steam generators are combustion equipment which are used to transfer heat from combustion gases to water to generate steam required for various applications. Boilers consist essentially of one or more burners, a firebox, heat exchanger, and auxiliary systems. Process heaters are also combustion equipment which transfer heat from combustion gases to water or other fluids. The primary fuel used in this source category is natural gas and/or oil (USEPA, 1973).

Regulatory History

Measure G11 of the 1982 AQMP Revision was originally proposed to reduce NO_X emissions from this source category (SCAQMD, 1982). The proposed Rule 1146, currently under development, is directed toward reduction of NO_X emissions from industrial, institutional and commercial boilers, process heaters, and steam generators. The proposed control measure is introduced in conjuction with the proposed Rule 1146 for this source category. Detailed description of the proposed measure is contained in the District's staff report on the proposed rule (SCAQMD, 1987).

PROPOSED METHOD OF CONTROL

This control measure proposes to reduce NO_X emissions to 40 PPMVD per 3 percent through the application of controls for this source category. The NO_X emission control technologies are essentially divided into two major categories: combustion modification and flue gas treatment.

The combustion modification methods can achieve NO $_{\rm X}$ emissions reduction either by reducing the temperature of combustion or reducing the amount of oxygen available for combustion. These methods include oxygen control systems, low-NO $_{\rm X}$ burners, and flue gas recirculation (FGR). Oxygen control systems can be utilized to reduce excess combustion air and thus lowering NO $_{\rm X}$ flue gas concentration. Low NO $_{\rm X}$ burners use a combination of fuel rich mixtures and staged combustion to reduce NO $_{\rm X}$ flue gas concentration. In the FGR method, flue gas is mixed with combustion air, which lowers the flame temperature and combustion temperature, thus reducing thermal NO $_{\rm X}$ formation.

Flue gas treatment systems use a reducing agent, usually ammonia, to react with NO $_{\rm X}$ and reduce it to nitrogen and water. There are basically two types of flue gas treatment technologies: selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR). In the SNCR method, ammonia is directly injected into the flue gas stream at around 1600°F, which results in overall reduction of NO $_{\rm X}$ emissions. In the SCR method, ammonia is first injected into the flue gas stream with a temperature of less than 800°F. The flue gas/ammonia mixture is then passed over a catalyst bed in a reactor vessel reducing NO $_{\rm X}$ emissions.

The use of methanol offers an additional option for controlling NO_X emissions from this source category. There are currently limited data available on the efficiency of methanol in industrial/commercial boilers, steam generators, and process heaters. Based on demostration projects on utility boilers and gas turbines, similar emission reductions can be expected for the above equipment. Further studies can verify the performance of methanol in these units.

EMISSIONS REDUCTION

In 1985, industrial, institutional, and commercial boilers, steam generators, and process heaters contributed to 10.8 tons per day of NO_{χ} in the Basin. These emissions are estimated to reach 12.2 and 13.1 tons per day in the years 2000 and 2010, respectively. The emissions reductions for this source category are expected to be 8.3 and 8.9 tons per day for the years 2000 and 2010.

COST EFFECTIVENESS

The cost effectiveness of the proposed measure for individual facilities ranges from \$6,800 to \$21,400 per ton of NO_x removed.

OTHER IMPACTS

Implementation of this measure is not expected to result in any significant adverse impacts. There may be some ammonia emissions due to chemical slippage, if SCR or SNCR is used.

REFERENCES

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. October 1982.

South Coast Air Quality Management District. 1987. <u>Proposed Rule 1146:</u> <u>Emissions Of Oxides of Nitrogen From Industrial Boilers, Steam Generators, And Process Heaters</u>. South Coast Air Quality Management District Staff Report. October 1987.

U.S. Environmental Protection Agency. 1973. <u>Air Pollution Engineering Manual</u>, Second Edition. 1973.

CONTROL OF EMISSIONS FROM STATIONARY GAS TURBINES [NO_x]

<u>SUMMARY</u>

Source Category: Stationary Gas Turbines

Control Method: Flue Gas Treatment System (SCR); Alternative Fuel

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 5.9 | 12.7 | 12.7 |
| | | 8.0 | 8.0 |

Control Cost: \$7,500 to \$24,600 Per Ton of NOx

Other Impacts: Increased District's workload; Increased CO

Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

The main function of gas-turbine units affected by this rule is to generate electricity. These units can add power to the regional electrical-power grid directly or displace utility supplied power by on-site generation with excess power going to the rid. The electrical energy-supply market can be categorized into three segments: utilities; on-site self-generators; and third-party-owned cogenerators. Exclusive on-site supply is typically less than a 10-MW (Mega Watt) unit. The third-party-owned cogeneration units generally range in size from 20 to 40 MW but a few units are less than 10 MW or more than 40 MW. The utility units, both simple and combined cycle, range in size from 19 to 133 MW. The current District stationary gasturbine capacity is estimated at 2426 MW with 1552 MW in operation and 874 MW new units to be completed.

The District's gas-turbine population can be broadly described as one half operated by the electric utilities and the other half operated by cogenerators, landfill and digester facilities, and emergency standby

generators. The electric utilities use their units as stand-by units or peaking units (i.e. whenever the need arises for added short-term energy supplies). This usage is intermittent and can range from 10 to 4000 hours per year, depending upon demand and economic dispatch considerations. The cogenerators, landfill, and digester yearly operations (hrs/yr) are on a continuous year-round basis typically greater than 8000 hours. Emergency standby generators are typically operated for maintenance testing at about 30 hours per year.

Regulatory History

The proposed Rule 1134 includes specific oxides of nitrogen (NO_{X}) emission concentration limits for new and existing stationary gas turbine units rated 0.3 MW and greater. The proposed limits are according to gas turbine unit size.

The history of this proposed rule goes back initially to a Suggested Control Measure that was adopted by the Air Resources Board in March of 1981. This was incorporated into the 1982 revision of the AQMP under Measure E-1: Electric Utility Gas Turbines NO_χ Control.

In the rule development process, the proposed Rule 1134 evolved to encompass various emission limits for a wider range of gas turbine applications.

PROPOSED METHOD OF CONTROL

The District's Engineering Division has set Selective Catalyst Reduction (SCR) as the NO $_{\rm X}$ control technology required for new units 2.9 MW and larger. This is also within the EPA criteria of LAER (Lowest Achievable Emission Rate). In addition, methanol fueling premixed with up to 20 percent water or used with low-NO $_{\rm X}$ combustors has generated significant NO $_{\rm X}$ reductions. These developments have provided the basis for the NO $_{\rm X}$ limits set forth in the proposed rule for new as well as existing equipment.

In SCR process, ammonia (NH₃) is used to react with the NO $_{\rm X}$ in the exhaust stream, reducing the NO $_{\rm X}$ to molecular nitrogen (N₂) and water H₂O). This is accomplished by mixing ammonia with the flue gas and passing the mixture over a catalyst bed. There are many SCR catalyst formulations available, each having varying degrees of desired properties such as effective temperature range, chemisorption or physical adsorption rate of oxygen, ammonia, and NO $_{\rm X}$, and resistance to poisoning.

The formation of NO_X can be minimized in gas turbines by lowering combustion temperatures. This can be accomplished by the staging of air to the combustion chamber by the cooling of flame temperatures with water or steam injection, or by the use of methanol fuel which burns at lower combustion temperatures. The least expensive, proven cost-effective NO_X control technology available is water (or steam) injection. A water

injection to fuel mass ratio of 0.8 can produce from 60 to 80 percent reduction of NO_X reduction, and a 2 percent fuel penalty. However, the energy output of a water-injected unit is increased slightly because of the increase mass flow rate by added water (vaporized) to the turbine. Proposed rule provisions for small units (less than 2.9 MW) can be met solely with water injection technology.

Continuous monitoring of NO $_{\rm X}$ emissions is required for all cogeneration and combined cycle units, 2.9 MW and larger. Continuous monitoring is also required for the flow rate of liquids and gases added to the combustion chamber or exhaust for reduction of NO $_{\rm X}$ emissions. Source testing of gas turbines, at least once a year, is required to verify the accuracy of monitoring equipment, and to assure compliance with the proposed emission limits.

To mitigate the disruption of operations, the staff proposes a two-tier compliance schedule for retrofit application of control equipment to existing gas turbines. A more detailed description of this control measure is contained in the Proposed Rule 1134 staff report (SCAQMD, 1987).

EMISSIONS REDUCTION

It is estimated that gas turbine units accounted for approximately 5.9 tons per day of NO_{X} emissions in 1985. In years, 2000 and 2010, NO_{X} emissions from this source category are expected to be about 12.7 tons per day. The projected NO_{X} emission reductions after implementation of the proposed rule are approximately 8.0 tons per day in the years 2000 and 2010.

COST EFFECTIVENESS

The cost effectiveness of the proposed measure ranges from \$7,500 to \$24,600 per ton of NO_X reduced.

OTHER IMPACTS

Implementation of this rule is expected to increase the District's workload. Increases in CO may result with the use of water injection or a methanol/water blend due to lower combustion temperature and incomplete

REFERENCES

South Coast Air Quality Management District. 1987. Proposed Rule 1134-Control of Oxides of Nitrogen from Stationary Gas Turbines. Rule Development Division. October 1987.

CONTROL OF FMISSIONS FROM ELECTRIC POWER GENERATING BOILERS [NO.]

SUMMARY

Source Category: Electric Power Generators

Combustion Modifications; Flue Gas Treatment Control Methods:

Systems; Alternative Fuels

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| No _x Inventory | 41.8 | 39.2 | 41.8 |
| No _x Reduction | | 27.4 | 29.2 |

Control Cost: \$15,200 to \$52,000 Per Ton of NO_v

Other Impacts: Increase in Ammonia Emissions; Spent Catalyst

Materials Handling

DESCRIPTION OF SOURCE CATEGORY

Background

The electric utility companies operate their plants in order to supply electric power to their customers on demand. Because electric power cannot be stored, it must be generated at the same instant it is consumed.

Electric power demand has a variation during the day. The demand is generally low during the night and early morning hours. Demand increases during the day as various things are turned on. During hot weather the load of air conditioners causes a very high demand which generally peaks in early afternoon at the time of highest temperatures. The demand for electric power decreases during the evening hours, reaching a minimum in the middle of the night.

The minimum load during the night is the base load. the increased load during the day time and early evening is the peak load. The electric power company must operate some generators continuously in order to supply the base load, and other generators must be cycled up and down in rate in order to supply the peak loads.

Nuclear generating plants and hydroelectric plants cannot rapidly change their loads and for this reason they are generally used to provide base load power. A boiler unit can change its load rapidly in response to demand changes and for this reason it is mostly used for peak loads.

An additional consideration is the fact that it requires several hours to place a boiler unit in operation that is out of service. For this reason it is not practical to shut down and start up a given plant every day as the load changes from base load to peak load and back again. Instead, the fired boiler plant must be operated to provide the peak load as needed and run at reduced capacity during the rest of the time.

The electric utility companies in the Basin generate and purchase a large portion of their electric power requirements from out of Basin sources. The boiler units and gas turbine units located in the Basin are used to provide the remainder of the power demand. There are 58 electric power generating utility boilers in the Basin with a total capacity of 10,251 megawatts.

Regulatory History

Proposed Rule 1135-Emissions of Oxides of Nitrogen from Electric Power Generating Equipment, is being developed pursuant to the District Board's direction based on the Public Hearing on "Controls of Oxides of Nitrogen (NOx)" held in February 1986 by the SCAQMD. Rule 1135 may require Selective Catalytic Reduction (SCR) or any other combination of controls to reduce NOx emissions on a bubble concept for each facility to a level of 0.03 pound NOx per million BTU's of heat input capacity.

Rule 1135.1 was adopted by California Air Resource Board (CARB) in March 1980, applied to electric utilities with generating capacity over 500 megawatts. This rule was rescinded on March 10, 1982 by the order of Superior Court judgment.

PROPOSED METHOD OF CONTROL

A diversity of technologies exist for controlling NO_X emissions from utility boilers. These fall into three categories: (1) Combustion modification, working by reducing the temperature of combustion and/or by reducing the oxygen available for combustion. These conditions favor lower NO_X formation; (2) Flue gas treatment systems such as Selective Catalytic Reduction (SCR), employ the use of ammonia as reducing agent to react with the oxides of nitrogen to yield molecular nitrogen gas and water; (3) Alternative fuel option of using methanol. A more detailed description of this proposed measure is contained in the staff report for the Proposed Rule 1135 (SCAQMD, 1988). Further demonstration projects may be required to verify the performance of methanol under efficient operating conditions.

FMISSIONS REDUCTION

Electric power generating boilers subject to Rule 1135 presently emitted about 41.8 tons per day of $NO_{\rm X}$ in the South Coast Air Basin in 1985. Projected emissions for the years 2000 and 2010 are expected to be 39.2 and 41.8 tons per day, respectively. Proposed Rule 1135 are expected to reduce $NO_{\rm X}$ emissions by 27.4 and 29.2 per day in 2000 and 2010.

COST EFFECTIVENESS

The cost effectiveness of the proposed measure ranges from \$15,200 to \$52,000 per ton of $\mathrm{NO_X}$ reduced.

OTHER IMPACTS

Ammonia, used as a reducing agent in SCR, is a toxic compound and its use, storage, and transport warant special concerns. The spent catalyst materials from the use of SCR commonly contain small amounts of hazardous materials which require to be either recycled or disposed of in a Class I landfill.

REFERENCE

South Coast Air Quality Management District. 1988. <u>Proposed Rule 1135 - Controlling Emissions of Oxides of Nitrogen From Electric Power Generating Equipment</u>. Rule Development Staff Report. February, 1988.

CONTROL OF EMISSIONS FROM AFTERBURNERS $[NO_{\times}]$

SUMMARY

Source Category: Afterburners (Direct Flame and Catalytic)

Control Methods: Post Combustion Treatment; Methanol;

Other Equivalent Control Technologies

Emissions: Not Determined

Control Cost: \$12,700 to \$124,000 Per Ton of NO $_X$ for Direct Flame \$25,400 to \$173,800 Per Ton of NO $_X$ for Catalytic

Other Impacts: Minor Effect On Plant Operation; Possible

Chemical Reaction Of By-Products.

DESCRIPTION OF SOURCE CATEGORY

Background

Afterburners are air pollution control equipment used to control volatile organic compounds (VOC) emissions from a wide variety of industrial processes. There are two types of afterburners: direct flame and catalytic. In a direct flame afterburner, organic compounds are combusted in a chamber at elevated temperatures using several burners. The catalytic type afterburner operates on the basis of oxidation of organics using catalysts at lower, preheated temperatures. Afteburners are generally connected to the exhaust of emission sources and can achieve up to 99 percent VOC destruction (USEPA, 1973; Pendle, 1988).

There are currently an estimated 550 direct flame and 50 catalytic afterburners in the South Coast Air Basin. Both types of afterburners use gaseous fuels as their primary fuel. The ${\rm NO}_{\rm X}$ emissions occur due to the high operating temperatures of afterburners (1400 $^{\circ}$ F to 2000 $^{\circ}$ F). The uncontrolled NO_X emissions are generally vented to the atmosphere and are estimated to be about 0.1 pounds per million BTU/Hr of heat input.

Regulatory History

The District requires permits for air pollution control equipment, including afterburners, under the requirments of specific processes and operations generating high VOC emissions. There is, however, no specific rule regarding control of NO_{Y} emissions from afterburners.

Due to an increasing number of afterburners used to control VOCs, the proposed control measure is directed toward the emission control of ${\rm NO}_{\rm X}$ from afterburners.

PROPOSED METHOD OF CONTROL

The proposed control measure to reduce NO_X emissions from this source category is through the application of post combustion treatment such as the urea injection process. The urea injection process, also called the NO_X -OUT system, is capable of reducing NO_X emissions by up to 70 percent based on demonstrations performed on various sizes of boiler equipment by the manufacturer.

The process involves the controlled injection of urea solution into the exhaust path of combustible gases and is most effective in the temperature range 1400°F to 1700°F . Urea reacts chemically with NO_{χ} present in the exhaust gas to form nitrogen, carbon dioxide, and water vapor with minimal by-products (i.e., ammonia). The high alloy type injectors use very small amounts of steam or air to atomize the urea reagent as it is introduced to the exhaust gases. If necessary, non-toxic organic compounds as chemical enhancers can be added, and/or the concentration of the reagent solution can be adjusted to widen the temperature range (1000°F - 2000°F) for effective chemical reaction, making the system applicable for a variety of operations (Mulhern 1988).

The urea injection system has recently become commercially available for both new and retrofit installations. Additional demonstrations on existing afterburners can verify the control efficiency. The system is custom-designed for each application in terms of physical configuration and size.

The use of methanol may provide another option for controlling NO_{χ} emissions from afterburners. Based on the utilization of methanol in boiler and turbine demonstrations, the emissions reduction potential for methanol can be equivalent to that of the urea injection process. Further demonstration tests can verify the control efficiency of methanol in afterburners.

Other control methods including advanced afterburner design, combustion modifications, and other stack gas treatment techniques with equivalent or better levels of emissions reduction are also applicable to this source category.

EMISSIONS REDUCTION

The NO_{X} emissions inventory from afterburners is currently not available. It is estimated that implementation of this measure will reduce emissions from this source category by 70 percent. The potential NO_{X} emissions reduction will be determined at a later date.

COST EFFECTIVENESS

Implementation of the NO_X -OUT system in afterburners would have a cost impact on equipment owners in the Basin. The cost effectiveness of the proposed control measure for direct flame afterburners is estimated to be \$12,700 to \$124,000 due to the relative low emissions from individual sources. The estimated cost effectivenes for catalytic afterburners is \$25,400 to \$173,800 due to considerable heat required to raise the exhaust temperture for effective urea reaction.

OTHER IMPACTS

The proposed measure will have minor effect on the overall plant operation since down-time for system installation is minimal. Identification of byproducts in the exhaust flow due to chemical reactions between enhancers and various components of the exhaust gas (e.g., ammonia) requires further study. The on-site storage and handling of the urea reagent does not pose a health and safety concern due to the non-hazardous nature of urea.

REFERENCES

Mulhern, M.R. 1988. Fuel Tech, Inc. Personal communication with Zorik Pirveysian, March 1988.

Pendle, Skip. 1988. Bayco Industries of California. Personal communication with Zorik Pirveysian, March 1988.

U.S. Environmental Protection Agency. 1973. <u>Air Pollution Engineering</u> Manual. May 1973.

CONTROL OF EMISSIONS FROM NON-UTILITY INTERNAL COMBUSTION ENGINES [ALL POLLUTANTS]

Source Category: Internal Combustion Engines (Non-Utility)

Control Method: Replacement With Electric Motors

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 7.8 | 8.5 8.5 | 8.8 8.8 |
| NO_X Inventory NO_X Reduction | 81.6 | 29.2 29.2 | 30.3 30.3 |
| CO Inventory CO Reduction | 36.1 | 40.9 40.9 | 43.3 43.3 |
| PM Inventory PM Reduction | 0.5 | 0.6 0.6 | 0.7 0.7 |
| SO_X Inventory SO_X Reduction | 0.5 | 0.6 0.6 | 0.7 0.7 |

Control Cost: \$6,700 to \$14,000 Per Ton Of NO_X

DESCRIPTION OF SOURCE CATEGORY

Background

Internal combustion engines are any spark or compression ignited reciprocating engines which are used for a variety of industrial processes, electric power generation, and fluid processing. Reciprocating internal combustion engines produce shaft power by confining a combustible mixture to make a small volume between the head of a piston and its surrounding cylinder, causing this mixture to burn, and allowing the resulting high

pressure products of combustion gases to push the piston. Power is converted from linear form (piston movement) to rotary form by means of a crankshaft.

Internal combustion engines are generally classified as (1) gasoline or gas engines, in which a spark plug is used to ignite a premixed fuel-air mixture; (2) diesel engines, in which high pressure compression raises the air temperature to the ignition temperature of the injected fuel oil (USEPA, 1979).

The primary pollutants from internal combustion engines are oxides of nitrogen (NO $_{\rm X}$), carbon monoxide (CO), and reactive organic gases (ROG) with small amounts of particulate matter (PM) and oxides of sulfur (SO $_{\rm X}$) which are mostly emitted through the exhaust.

Regulatory History

Internal combustion engines are currently regulated under Rule 1110.1, which requires that emissions from these engines to be reduced to specified limits. The proposed control measure introduced herein is directed toward complete elimination of all potential pollutants emissions from this source category by replacing non-utility internal combustion engines with electric motors.

PROPOSED METHOD OF CONTROL

The proposed control measure is to require that all non-utility internal combustion engines not used for emergency standby be phased out and replaced with electric motors. Electrification of internal combustion engines not only involves the installation of electric motors, but also it requires the installation of motor starter(s), distribution system, and possibly substation(s) and transformer(s) depending on specific application and location.

Electrification of internal combustion engines has been implemented elsewhere; therefore, the technology is commercially available (Shafritz, 1988). Based on the control measure CM #88-F-10 methonal can be used on standby for emergency back-up internal combustion engines.

EMISSIONS REDUCTION

In 1985, internal combustion engines emitted 81.6 tons per day of NO $_{\rm X}$, 36.1 tons per day of CO, 7.8 tons per day of ROG, 0.5 tons per day of PM, and 0.5 tons per day of SO $_{\rm X}$. The estimated emissions in the year 2000 are 29.2 tons per day of No $_{\rm X}$, 40.9 tons per day of CO, 8.5 tons per day of ROG, 0.6 tons per day of PM, and 0.6 tons per day of SO $_{\rm X}$. The comparative emissions for the year 2010 are 30.3 tons per day of NO $_{\rm X}$, 43.3 tons per day of CO, 8.8 tons per day of ROG, 0.7 tons per day of PM, and 0.7 tons per day of SO $_{\rm X}$. The decline in emissions is due to full implementation of Rule 1110.1.

Implementation of the proposed measure is expected to result in total reduction of the above emissions based on the assumption that the required excess power to operate the electric motors will be imported from out-of-Basin.

COST EFFECTIVENESS

Uncontrolled NO $_{\rm X}$ emissions were assumed to be 12.75 gms/hp-hr. Rule 1110.1 will control 80 percent of all existing NO $_{\rm X}$ emissions; hence, it was assumed that electric motors will control the remaining 20 percent. The cost effectiveness was determined to be \$6,700 per ton of NO $_{\rm X}$ based on a natural gas cost of 50 cents per therm, or \$14,000 per ton of NO $_{\rm X}$ reduced based on a natural gas cost of 25 cents per therm. It should be noted that the control expenditures estimated for NO $_{\rm X}$ reduction can simultaneously reduce other pollutants emissions.

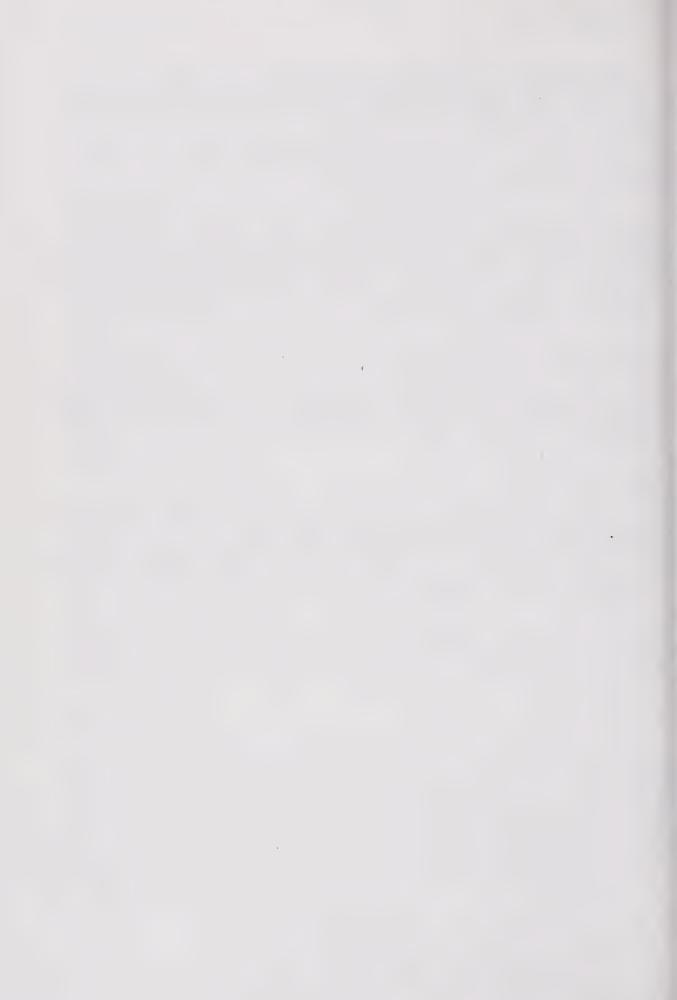
OTHER IMPACTS

Implementation of the proposed control measure is not expected to result in any adverse impacts in the Basin. It should be noted that the control expenitures estimated for NO_{χ} reduction can simultaneously releaase other polluants emissions.

REFERENCES

Shafritz, Brian. 1988. Santa Barbara Air Pollution Control District. Personal Communication With Elaine Chang, March 1988.

U.S. Environmental Protection Agency. 1979. <u>Stationary Internal Combustion Engines; Dreaft EIS</u>. EPA-450/2-78-125a.



D- RESIDENTIAL AND PUBLIC SECTORS

The control measures proposed for reducing emissions from residential and public sectors source categories are listed in Table I-2D. The concepts of control measures for each of these sources are described in the following section.

TABLE I-2D TIER I CONTROL MEASURESRESIDENTIAL AND PUBLIC SECTORS

| AQMP | CONTRO No. | TITLE |
|------|---------------|--|
| D-1 | | Control of Emissions from Starter Fluid, [ROG] |
| D-2 | | Application of Solar Panels on Residential Water Heaters, $[NO_\chi]$ |
| D-3 | | Application of Heat Transfer Modules on Residential Heating Furnaces, $[NO_X]$ |
| D-4 | | Addition of Flue Dampers on Residential Water Heaters, $[NO_X]$ |
| D-5 | | Out-of-Basin Transportation of Biodegradable Solid Waste, [All Pollutants] |
| D-6 | | Control of Fugitive Emissions from Publicly Owned Treatment Works, [ROG] |
| D-7 | | Control of Emissions from Utility Equipment, [All Pollutants] |

CONTROL OF EMISSIONS FROM STARTER FLUID [ROG]

SUMMARY

Source Category: Control of Emissions From Starter Fluid

Use of Alternative Barbecues; Reformulation; Control Methods:

Restrict Usage on Summer Smog Episode Days

Fmissions: Not Determined

Control Cost: Not Determined

Other Impacts: Safer Operation *******************

DESCRIPTION OF SOURCE CATEGORY

Background

Starter fluid, also referred to as lighter fluid, is used to facilitate igniting charcoal and wood in outdoor barbecues, charcoal grills, campfires, and patio torches. The greatest use of starter fluid coincides with the season of high ozone concentrations in the Basin.

Starter fluid is made up of petroleum distillate which is comprised almost entirely of photochemically reactive organic compounds. Although much of the fluid is consumed during ignition, some of the fluid vaporizes shortly after it is applied. Directions on use of these products often instruct the user to liberally apply the fluid and wait for several minutes to allow the charcoal to absorb the fluid.

Regulatory History

Currently, there are no regulations to control emissions from starter fluid and emissions from this source category are only limited to Rule 402 which is directed to control emissions causing nuisance to the public.

PROPOSED METHOD OF CONTROL

This measure proposes a three-fold approach to reducing ROG emissions from starter fluid: (1) prohibit the sale of barbecues which require starter fluid; (2) require that starter fluid be reformulated with less photochemically reactive constituents; (3) restrict the use of starter fluid on summer smog episode days and discourage the use of starter fluid in general, through public information programs.

Currently, there are sevaral alternative types of barbecues marketed which do not require the application of starter fluid. Propane barbecues are portable and emit less reactive organic gases since the fuel is directly fed to the flame broiler. Electric barbecues and electric starters are also marketed but are less portable. Most outdoor recreational areas do not have electrical outlets, therefore, substitution with propane barbecues is more feasible. For those barbecues used only in the backyard or patio, electric barbecues can replace conventional models.

It is difficult to control the use of all starter fluid used to ignite campfires and patio torches. For these uses, starter fluid products marketed in the basin are required to be reformulated/substituted with less photochemically reactive compounds, such as methanol.

Finally, it is proposed to ban the use of starter fluid in public areas on days in which the ozone standard is predicted to equal or exceed the national secondary standard (first, second, or third stage smog episodes). The restriction can be acheived by posting signs in public parks and recreational areas where barbecues and starter fluid are used the most. Also, the use of starter fluid could be discouraged through public information programs. In particular, the public could be encouraged to curtail outdoor barbecue activities on summer days with high ozone concentrations.

EMISSIONS REDUCTION

The emissions of starter fluid vapors are uncertain and require further analysis. It is important to note, however, that the use of starter fluid is seasonal and emissions per day from this source category is not consistent.

COST EFFECTIVENESS

The cost impacts associated with this measure vary due to variation in control methods. The cost effectiveness of the proposed control options is uncertain due to unknown emissions inventory and reduction potential, and requires further analysis. Electric barbecues are advertised as more economical than barbecues using starter fluid.

OTHER IMPACTS

Electric barbecues and electric starters are considered to be cleaner and safer to operate than conventional barbeques, since there is no application of starter fluid.

APPLICATION OF SOLAR PANELS ON RESIDENTIAL WATER HEATERS [NO_X]

<u>SUMMARY</u>

Source Category: Residential Water Heaters

Control Methods: Installation of Flat Plate Solar Collectors

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 12.3 | 9.0 4.7 | 10.2 5.3 |

Control Cost: \$530,000 Per Ton of NO_x

Other Impacts: Possible Adverse Impact of Housing Costs on

Low/Moderate Income Households

DESCRIPTION OF SOURCE CATEGORY

Background

Currently in the District there are about 3.3 million natural gas-fired water heaters using fuel at an average rate of about 65 cubic feet per day per unit. The average unit life is ten years. About 22 percent of the residences use electric or share "commercial" gas water heaters (Gaines, 1987), which would not be affected by this proposed control measure. Domestic solar water heating is a well developed technology which offers a means to reduce natural gas consumption and NO_X emissions. California State standards in hardware quality have been established for solar units. Federal and state tax incentives which promoted solarization are no longer

Regulatory History

District Rule 1121 regulates the ${\rm NO}_{\rm X}$ emissions of residential gas-fired water heaters, and has limited ${\rm NO}_{\rm X}$ emissions to 40 nanograms per joule of heat output, or approximately 2.3 pounds per year per new unit since

January 1, 1983. Full compliance is expected by the end of 1992, when 3.64 million water heaters are expected in the District.

In addition, since the rule's adoption in 1978, the California Energy Commission (CEC) adopted ASHRAE-90 Standards (in 1978-79), which increased the average seasonal efficiency from 46 to 55 percent (Messenger, 1987), with a corresponding emission reduction of 16 percent when all units are replaced.

Based on Measure N2 of the 1982 AQMP Revision (SCAQMD, 1982), this control measure is modified to incorporate the current District water heater NO_X rule.

PROPOSED METHOD OF CONTROL

 ${
m NO}_{
m X}$ emissions from natural-gas-fired residential water heaters should be controlled by requiring the installation of flat-plate solar collectors on new and replacement water heating systems. Conventional water heaters would continue to be used to back up the solar component.

On a yearly basis, solar energy could provide about 52 percent of the energy needed for a given water heating system, with the remaining 48 percent provided by the conventional natural gas unit in compliance with the District Rule 1121 and CEC standards. Assuming an average unit life of 10 years, full implementation would be expected within 10 years.

EMISSIONS REDUCTION

Domestic water heaters accounted for approximately 12.3 tons of NO_{χ} per day in 1985. This is expected to fall to 9.0 tons per day at the end of 2000 when Rule 1121 achieves full implementation. Emission estimates for 2010 are 10.2 tons per day due to population growth.

Implementation of this measure should provide a 52 percent NO_X emissions reduction, approximately 4.7 tons per day in 2000, and 5.3 tons per day in 2010.

COST EFFECTIVENESS

The addition of the solar panels will increase the cost of water heater systems by about \$4,000. Fuel savings are estimated to be about 128 therms per year. At an average annual cost of 90 cents per therm (SCGC, 1987), this will result in approximately \$113 annual fuel saving. Based on above assumptions the cost effectiveness for this control measure would be \$530,000 per ton of NO_X removed.

OTHER IMPACTS

Residential natural gas consumption would be reduced by about 32.8 cubic feet per day per unit, or 6.3 million equivalent barrels of oil yearly basinwide.

Housing costs would increase about \$4,000 per unit, reflecting the cost of the system. This could adversely affect low and moderate income homeowners, especially since tax credits for solar installation have expired. The expiration of these credits, along with currently low energy prices, greatly lengthens the payback period.

REFERENCES

Gaines, Mark. 1987. Southern California Gas Company. Personal communication with Larry Irwin, November, 1987.

Messenger, Mike. 1987. Caliofornia Energy Commission. Personal communication with Larry Irwin, November 1987.

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. Appendix VII-A, Measure N2. El Monte, CA. October 1982.

Southern California Gas Company. 1987. "Fact Sheet".

APPLICATION OF HEAT TRANSFER MODULES ON RESIDENTIAL HEATING FURNACES $[\mathrm{NO}_{\times}]$

SUMMARY

Source Category: Gas-Fired Fan Type Central Furnaces

Control Methods: Heat Transfer Module

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--|------------------|------------------|------------------|
| NO _x Inventory NO _y Reduction | 13.6 | 13.8 | 15.5 10.9 |

Control Cost: \$41,500 Per Ton of NO_X

DESCRIPTION OF SOURCE CATEGORY

Background

Currently in the District there are about 1.6 million gas-fired central residential furnaces using fuel at an average rate of 40,000 cubic feet per year per unit. The average unit life is about 20 years. About 60 percent of the residences use electric or some other form of gas space heating, which would not be affected by this proposed control measure. NO $_{\rm X}$ emissions from these furnaces can be reduced with current technology by use of heat transfer modules.

Regulatory History

Measure N16 of the 1982 AQMP Revision and of the Revision to the Federal Nitrogen Dioxide Attainment Strategy has previously proposed this control measure. No implementation action has been taken. Therefore, measure N16 is being reintroduced.

This control measure would improve the current District Rule IIII, which limits the ${
m NO}_{
m X}$ emissions to 40 nanograms per Joule of useful heat.

PROPOSED METHODS OF CONTROL

The control technique requires the use of a heat transfer module which employs a burner/heat exchanger, reducing the NO_X emissions to 12 nanograms per Joule (output). The technique uses a glycol solution to transfer heat from an outdoor burner to an indoor heat exchanger. The heat transfer module would replace the conventional central furnaces at the time of replacement which is normally every twenty years (SCAQMD, 1982).

EMISSIONS REDUCTION

Gas-fired fan-type central residential furnaces accounted for approximately 13.6 tons of NO_{χ} per day in 1985. Emission estimates for 2000 and 2010 are 13.8 and 15.5 tons per day, respectively.

Implementation of this control measure should provide a 70 percent emissions reduction, approximately 10.9 tons per day in 2010 based on complete replacement of existing units within 20 years.

COST EFFECTIVENESS

Implementation of the proposed control measures will increase the cost of residential heating furnaces. The cost effectiveness for this control measure will be \$41,500 per ton of NO_x reduced.

OTHER IMPACTS

These units are top-of-the-line models and may be economically out-of-reach for most people. However, they will prove to be more feasible in the future. The design is presently offered by only one manufacturer.

REFERENCES

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan, Appendix VII-A, Measure N16. El Monte, CA.

ADDITION OF FLUE DAMPERS ON RESIDENTIAL WATER HEATERS [NOx1

SUMMARY

Source Category: Residential Water Heaters

Control Methods: Stack Vent Valves (Dampers)

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 12.3 | 9.0 0.7 | 10.2 0.8 |

Control Cost: Savings

Other Impacts: Conservation of Natural Gas *****************

DESCRIPTION OF SOURCE CATEGORY

Background

Currently in the District there are about 3.3 million natural gas-fired water heaters using fuel at an average rate of about 65 cubic feet per day per unit. The average unit life is ten years. About 22 percent of the residences use electric or share "commercial" gas water heaters (Gaines, 1987), which would not be affected by this proposed control measure.

While in the standby mode of operation, water heaters lose stored heat through the convection of gases through the stack. Cutting off the flow of these gases during standby can reduce these heat losses, thereby reducing the amount of combustion. Stack vent valves (dampers) are already produced for this purpose as an internal part of commercial water heaters. However, they are not marketed on residential water heaters.

Typically, water heaters are 76 percent energy-efficient while operating (recovery efficiency), but only 55 percent overall (seasonal efficiency). The standby losses account for the difference in these two numbers, and about two-thirds of that is due to heat losses through the venting system (Nordstrom, 1987).

As technology developed higher efficiencies to meet recent state standards, the standby losses of new units were lowered from an average of 5.7 to 3.7 percent per hour (DeWerth, 1985). In pursuit of energy conservation, power burners, submerged combustion chambers, and heat-pipes have recently been developed and are currently penetrating the market. However, efficiency is not a major driver in the replacement market, according to most installers.

Regulatory History

District Rule 1121 regulates the NO_X emissions of residential gas-fired water heaters, and has limited NO_X emissions to 40 nanograms per joule of heat output, or approximately 2.3 pounds per year per new unit since January 1, 1983. Full compliance is expected by the end of 1992, when 3.64 million water heaters are expected in the District.

In addition, since the rule's adoption in 1978, the California Energy Commission adopted ASHRAE-90 Standards (in 1978-79), which resulted in increasing the average seasonal efficiency from 46 to 55 percent (Messenger, 1987), with a corresponding emission reduction of 16 percent when all units are replaced.

Measure N18 of the 1982 AQMP Revision (SCAQMD, 1982) and the Revision to the Federal Nitrogen Dioxide Attainment Strategy proposed altered design of residential water heaters. Since no implementation action has been taken, Measure N18 is herein being reintroduced.

PROPOSED METHOD OF CONTROL

Heat stored during the standby mode of water heaters should be conserved by extending the application of vent valves (flue dampers) from the commercial sector to the residential market. Reducing the heat losses reduces fuel consumption and the associated emissions.

Tests have shown that vent valves (dampers) would reduce fuel consumption by 8 percent or about 20 therms per unit per year (Macriss et al., 1980).

EMISSIONS REDUCTION

Domestic water heaters accounted for approximately 12.3 tons of NO_{χ} per day in 1985. This is expected to fall to 9.0 tons per day in the year 2000 when Rule 1121 achieves full compliance. Emission estimates for 2010 are 10.2 tons per day.

Implementation of this measure should provide an 8 percent emissions reduction, approximately 0.7 tons per day in 2000, and 0.8 tons per day in

COST EFFECTIVENESS

The cost of adding a flue gas damper is \$100. This would generate about 20 therms of natural gas savings annually for an average househould. At 90 cents per therm marginal price, the amount saved is \$18 annually. The annual present value of such savings is \$146, exceeding the installed cost. Thus this measure would generate savings.

OTHER IMPACTS

There will be about an 8 percent reduction in natural gas consumption. The added cost of a damper on conventional units would tend to lower the cost differential of moving the current technology of high-efficiency (80 to 95 percent) prototypes into the marketplace.

REFERENCES

DeWerth, W. Douglas. 1985. <u>Status of Water Heating Technology: 1985</u>. American Gas Assn. Laboratories for the Gas Research Institute. November 1985.

Gaines, Mark. 1987. Southern California Gas Company. Personal communication with Larry Irwin, November 1987.

Macriss, R.A., T.S. Zawacki, and J.W. Zimmer. 1980. <u>Research</u>, <u>Development</u>, and <u>Demonstration of a High-Efficiency Gas Fired Water Heater: Annual Report for 1979</u>. Institute of Gas Technology, Chicago, IL. Prepared for Gas Research Institute, Contract 5011-345-0093. January 1980.

Messenger, Mike. 1987. California Energy Commission. Personal communication with Larry Irwin, November 1987.

Nordstrom, Ed. 1987. Amtrol Inc. Personal communication with Larry Irwin, October 1987.

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan. Appendix VII-A, Measure N18. El Monte, CA.

Southern California Gas Company. 1987. "Fact Sheet". Spring 1987.

OUT-OF-BASIN TRANSPORT OF BIODEGRADABLE SOLID WASTE [ALL POLLUTANTS]

SUMMARY

Source Category: Landfill Gas; Landfill Gas Combustion;

Landfill Dust; Heavy Duty Vehicle Transport

of Solid Waste

Control Methods: Require All Biodegradable Solid Waste Be

Transported Out of the Basin for Disposal

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 6.4 | 4.0 | 4.0 4.0 |
| ${\it NO}_X$ Inventory ${\it NO}_X$ Reduction | 0.7 | 2.0 2.0 | 2.0 2.0 |
| SO_X Inventory SO_X Reduction | 0.8 | 2.0 | 2.0 2.0 |
| PM Inventory PM Reduction | 0.5 | 1.0 1.0 | 1.0 1.0 |
| CO Inventory CO Reduction | 1.2 | 3.0 3.0 | 3.0 3.0 |

Control Cost: Not Determined

Other Impacts: Reduced Toxic Emissions Generated in Landfills

and Reduced Nuisance Impacts of Landfills to

Surrounding Neighborhoods

DESCRIPTION OF SOURCE CATEGORY

Background

Solid waste generated in the Basin has been disposed of by burying in sanitary landfills located in and around the perimeter of the Basin. This method of disposal began in the 1950's when the Los Angeles County Air Pollution Control District banned on-site waste incineration as an air pollution control measure. As the original landfills reached capacity, new landfills were developed. Over the last five years new sanitary landfill capacity within a convenient hauling distance of the sources has been difficult to obtain due to opposition from neighboring citizens. The difficulty in locating new sanitary landfills led to proposals for building centralized solid waste incinerators. Twelve such incinerators in all were proposed but only two projects were able to proceed to construction; the others were abandoned due to strong citizen opposition. A shortfall of available landfill capacity in some parts of the Basin is forecasted by 1991 if no new landfills or landfill expansions are permitted.

Both sanitary landfills and solid waste incinerators are sources of emissions. Landfills generate organic gases as a result of anaerobic decomposition of biodegradable solid waste buried in the landfill; the gas eventually migrates to the surface where it can escape into the atmosphere. Decomposition of buried solid waste occurs over a period of 10 to 20 years.

Recently there has been a great deal of discussion on how to handle the solid waste generated in the Basin as existing landfill capacity is exhausted. Source separation, waste minimization, composting, and recycling have been discussed and are being implemented in some localities. These practices will contribute to a reduction in both the amount of emissions from solid waste decomposition and emissions from solid waste transport. Suggestions have been made to transport all solid waste out of the Basin for disposal. Efforts to site both new landfills and site solid waste incinerators are continuing.

Regulatory History

Landfill gas was first recognized as an air pollution source in 1980; Rules 1150.1 and 1150.2 require active and inactive landfills to install systems for collecting and flaring the gas. This rule eliminated most of the organic gas emissions but created landfill gas flaring as a new source of NO_x plus minor amounts of ROG, SO_x and CO. Solid waste incinerators emit NO_x plus minor amounts of ROG, SO_x and co. Solid waste incinerators emit ROG, NO_x, SO_x, PM, CO, and some toxic air pollutants. If any new incinerators are constructed, they will be required to obtain emission offsets, probably consuming a large fraction of the offsets likely to be available.

PROPOSED METHOD OF CONTROL

Of the three solutions to the Basin's solid waste disposal problem (transportation out of the Basin, new landfill sites, and solid waste incineration), only transport out of Basin eliminates solid waste decomposition as a source of emissions. With recycling and source separation, combustible solid waste can be converted to a fuel which could be marketed for use in electrical power plants outside the Basin. This

type of fuel is referred to as refuse derived fuel (RDF). Facilities currently exist outside of California for converting solid waste to RDF.

Transport of RDF out of the Basin could be a major new source of emissions if efforts are not made to take advantage of opportunities for intelligent sitting of RDF conversion facilities. The most economical and lowest emitting means of transport of such a material over any significant distance is by rail. Electrification of raillines is one of the most cost-effective AQMP control measures. Thus for the purposes of this discussion it is assumed that all such transport is by electrified raillines resulting no additional emissions from rail transport of RDF. Sitting of RDF conversion facilities adjacent to raillines can minimize transport emissions. This would eliminate the need to transport RDF by any means other than rail. Further, since the Basin is well served by raillines in areas zoned for industrial use and these areas are at the center of most urbanization, the ton-miles of transport of solid waste could also be reduced from todays levels.

EMISSIONS REDUCTION

Landfills

Emissions from solid waste landfills (both escaping gas and flaring) increase as population increases under the assumption that all solid waste is landfilled and per capita solid waste generation remains unchanged. In 1985, ROG emissions from escaping gas and flaring combined were 6.4 tons per day. The NO $_{\rm X}$, SO $_{\rm X}$, CO and PM emissions from flaring were estimated to be 0.7, 0.8, 1.2, and 0.5 tons per day, respectively. The projected emissions for the years 2000 and 2010 are contained in the summary table. Elimination of landfilling would prevent any additional solid waste from beginning the decomposition process in the Basin. All buried solid waste would be allowed to complete the decomposition process over a period of about 15 years until the emissions approach zero.

Other landfill emission sources are dust generated from hillside grading, and exhaust emissions from grading equipment. Emissions from these types of sources are included in the emissions inventory but are not able to be separated specifically for landfills.

RDF Conversion Facilities

RDF conversion facilities would be new sources of emissions.

Transport Of Solid Waste and RDF

The emissions required to transport RDF out of the Basin is assumed to be zero through the use of electrified raillines. The reduction in emissions from transport of solid waste to centrally located RDF conversion facilities instead of landfills is difficult to calculate. In order for

RDF to be feasible, extensive source separation would be required. Source separation may be needed to enable recycling to reduce the overall waste problems of the Basin whether or not RDF conversion is included. With source separation, recycling becomes a major component of the waste disposal system, greatly altering the transport of solid waste in the Basin.

COST EFFECTIVENESS

The cost-effectiveness of this measure can only be determined by comparing this proposal against other long run proposals for handling the solid waste problems of the Basin which do not consider air quality impacts. This proposal may in fact be the lowest cost method of disposing of biodegradable solid wastes generated in the Basin irrespective of any air quality concerns.

OTHER IMPACTS

Landfills generate toxic air pollutants along with criteria air pollutants. This control measure would gradually eliminate landfills as a source of these pollutants.

REFERENCES

South Coast Air Quality Management District. 1986. <u>Hazardous Pollutants in Class II Landfills</u>. Laboratory Services Branch, Technical Services Division. December 1986.

South Coast Air Quality Management District. 1987. <u>Impact Assessment of Waste-to-Energy Projects and Alternatives in the South Coast Air Basin</u>. Planning Division. March 1987.

CONTROL OF FUGITIVE EMISSIONS FROM PUBLICLY OWNED TREATMENT WORKS [ROG]

SUMMARY

Source Category: Publicly Owned Treatment Works

Control Methods: More Stringent Limits for Industrial Effluent

Discharged to Sewage Treatment Plants; Add-On

Controls at the Sewage Treatment Plant

Emissions:

ROG Inventory: Not Determined

ROG Reduction: Potential of About 1.0 Ton per Year

Control Cost: Not Determined

Other Impacts: Decreased Emissions of Toxic Air Contaminants;

Potential Increased Disposal of Waste Materials

into Class I Landfills

DESCRIPTION OF SOURCE CATEGORY

Background

Publicly owned treatment works (POTWs), commonly referred to as sewage treatment plants, receive residential and industrial wastewaters which contain volatile organic compounds. During wastewater treatment these organic compounds can be vaporized and be emitted to the air. A portion of the resultant emissions are photochemically reactive and contribute to ozone formation. These emissions also contain other toxic air contaminants (Chang et al., 1987).

The study of air emissions from POTWs is a new area of investigation and as a result only limited data are currently available. These data indicate that the amount of ROG purged to the air is directly correlated to the quantity of organics contained in the influent and the amount of agitation (e.g., aeration) the wastewater undergoes. The emissions characteristics

are therefore highly site specific and dependent on each plant's design and the types of influent that it receives.

Studies conducted thus far in the South Coast Air Basin indicate that POTWS emit small quantities of a large number of toxic air contaminants, but have relatively low overall ROG emissions. The current best estimate of ROG emissions for the largest POTWs which receive industrial wastewaters, per facility, is on the order of 100-200 lbs/day. There are only a handful of these large facilities in the Basin. The majority of the POTWs are relatively small, only treat limited quantities of industrial wastewater, and are therefore expected to have much lower daily emissions.

PROPOSED METHOD OF CONTROL

At the present time there appear to be two approaches available to reduce fugitive ROG emissions from POTWs. One approach is for local governments to establish stricter limits on the types and amounts of purgeable ROG which are discharged by industrial sources to the POTWs. This will also reduce the emissions that occur from the sewer lines as the wastewaters travel to the treatment plants. The other approach is to require POTWS to capture their fugitive ROG emissions and vent the emissions to control devices. If it becomes necessary to require controls at the POTWs, there are a number of devices, such as carbon canisters and scrubbers, which appear suitable. In fact, some POTWs already have enclosed systems which are vented to control devices for odor reduction purposes. Also, there is a trend toward using "100 percent" secondary treatment which requires enclosing open systems and could facilitate the use of add-on control devices.

Placing greater restrictions on the types and quantities of organics discharged to POTWs is within the jurisdiction of local governments and the EPA, whereas requiring controls at the POTWs is within the District's authority.

EMISSIONS REDUCTION

Based on available information, it appears that the ROG emission reduction potential of this measure is about 1 ton per day. Completion of studies underway by POTW operators, the California Air Resources Board and District staff will provide a basis upon which to refine this estimate and determine current and projected future emission reductions.

COST EFFECTIVENESS

Both of the proposed control approaches will impose costs on the affected parties. These cost cannot be quantified until further data are collected and specific control actions developed.

OTHER IMPACTS

Adoption of this measure will facilitate greater use of recycling and solvent reclamation techniques, but may also result in greater disposal of spent materials to Class 1 landfills. Stricter controls on industrial dischargers will also decrease toxic air emissions and contamination of soils and underground water supplies by reducing the amount of organics which migrate out of the sewer lines to surrounding media.

In addition to ROG emissions, other potentially toxic, non-photochemically reactive emissions as well as photochemically reactive emissions are controlled.

REFERENCES

Chang, D.P.Y., E.D. Schroeder, and R.L. Corsi. 1987. <u>Emissions of Volatile and Potentially Toxic Organic Compounds from Sewage Treatment Plants and Collection Systems</u>. Department of Civil Engineering, University of California, Davis. July 1987.

CONTROL OF EMISSIONS FROM UTILITY EQUIPMENT [ALL POLLUTANTS]

Source Category: Domestic & Commercial Utility Equipment,

(Lawn & Garden, Chain saws, General Utility)

Electrification; Engine Modifications; Control Methods:

Substitute 4-Stroke for 2-Stroke; Substitute Methanol for Gasoline.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | 13.1 | 19.6 | 23.1 |
| ROG Reduction | | 17.7 | 20.7 |
| CO Inventory | 142.8 | 217.3 | 256.0 |
| CO Reduction | | 162.9 | 192.0 |
| NO_X Inventory NO_X Reduction | 2.2 | 3.4 | 4.0 |
| | | 0.7 | 0.8 |
| $S0_X$ Inventory $S0_X$ Reduction | 0.2 | 0.3 Not Dete | 0.4 ermined |
| PM Inventory | 0.4 | 0.5 | 0.6 |
| PM Reduction | | Not Dete | ermined |

Control Cost: \$2,000 Per Ton of ROG or

\$200 Per Ton of CO

Other Impacts: Statewide Implementation May be Required to Ensure

Local Compliance; Energy Conservation; Noise

Abatement; Dust Abatement; Gardening Practices

DESCRIPTION OF SOURCE CATEGORY

Background

Utility equipment used in both the residential and commercial sectors can be sub-divided into three categories: lawn and garden (including walkbehind mowers, rototillers, trimmers, and blowers), chain saws, and general utility (such as generators, compressors, pumps, grinders, refrigeration units, and welding machines). Utility equipment is powered by two- or four-stroke gasoline engines or electric motors. Emissions from the combustion of gasoline in two- and four-stroke engines having less than 20 hp are used to inventory the emissions from this source category. Emissions which can be controlled from this equipment include ROG, NO $_{\rm X}$, and CO, and to a much lesser degree SO $_{\rm X}$ and PM.

The tow-stroke engine have significantly more emission per unit of energy output than four-stroke engine. In 1979 two-stroke engines comprised about 29 percent of the gasoline-powered lawn and garden utility equipment and generated about 45 percent of the total ROG emissions. With the growth of the new leaf-blower industry, these percentages are currently expected to be somewhat higher.

Presently, about 5 to 10 percent of the walk-behind lawn mowers, 70 percent of the chain saws, and 80 percent of the hand-held equipment (e.g. leaf blowers/vacuums, weed and hedge cutters,) sold locally are electrically powered (Sears, 1987). The remainders are powered by 4-stroke engines for lawn mowers and 2-stroke engines for chain saws and hand-held equipment. Rototillers are predominantly powered by 4-stroke engines.

Nationally, 2.7 percent of the walk-behind lawn mowers are electrically powered, and 4.5 percent are 2-stroke (Young, 1987). The primary reasons for using electric and 2-stroke engines are lightness of weight and vertical rotatability. The primary buyers of electric equipment are probably home owners.

Regulatory History

A measure directed at utility equipment (M10) was introduced in the 1982 AQMP as an ARB action item, but no action was taken. In 1985 it was determined that, of utility equipment, only rider mowers and garden tractors are motor vehicles and, therefore, under the jurisdiction of the ARB (Boyd, 1985). ARB does not currently have regulations under development for this equipment. All other utility equipment is under local district jurisdiction.

Recently a number of cities have debated banning or restricting leaf blowers because of noise complaints. Cities that have banned them include Beverly Hills, Carmel (McCraw, 1985), Palos Verdes Estates, Lomita (La Jeunesse, 1987), and West Hollywood (Barber, 1987). Santa Monica has confined the use of blowers to daytime hours (La Jeunesse, 1987). The Los Angeles City Council rejected a proposed plan in 1986.

City of Pasadena set the timeframe of their use, limited their usage in minutes/hour/parcel, requires annual certification, and prescribes accountability for their proper use. City of Claremont currently limits their operating hours, and will ban them as of October 1989, if the leaf-blowers do not comply with state noise standards and their manufacturers do

not address dust and pollution issues satisfactorily (Taylor, 1988). City of San Marino has held public hearings on proposed ordinances.

The District has authority to set emission limits on and/or ban gasoline powered utility equipment sold in the District.

PROPOSED METHOD OF CONTROL

A combination of electrification and engine modifications seems to be the most appropriate control option. The use of methanol would be a long range control option.

Electrification

Since electrical technology has the lowest emission characteristics and is available for lawnmowers and all the hand-held equipment, promoting/requiring the sale/use of electrical equipment would be the most desirable control option. All lawn and garden equipment could be required to be electric powered. For those application where electric power is not readily available, low emission portable generators would be available (see below).

The above approach has the advantage that given a choice, most users of electric powered lawns and garden equipment would opt for use of commercially available electricity rather than the use of a portable generator, even if a generator is at hand. Substitution of electrical for gasoline-powered equipment would essentially eliminate all emissions. Emissions from power plants due to additional power demand by electric utility equipment is neglible, since up to 80 percent of the Basin power supply comes from out of Basin sources.

Engine Modifications

Electrification is impractical in some applications. Examples are electrical generators and some uses of chain saws where electric cords would pose a safety hazard. In gasoline-powered equipment for which replacement by electrical equipment is infeasible or inappropriate, oxidation catalytic devices and improved carburetor calibration can reduce ROG and CO emissions by about 50 to 95 percent, without significant change in NO $_{\rm X}$. In addition, two-stroke designs can be substituted with four-stroke designs to reduce emissions. For equipment having this substitution, ROG is reduced by about 89 percent (214 to 23 gms per hp); CO by about 43 percent (486 to 279 gms per hp); and NO $_{\rm X}$ is raised by 100 percent (1.6 to 3.2 gms per hp).

Methanol Fuel

Substitution of methanol for gasoline is estimated to reduce ROG by about 50 percent (Wallerstein, 1988). Reduction in CO and NO_X are also expected, but by insignificant amounts due to small baseline values. The use of

methanol would require extensive equipment development or material changes in current engines for compatability with alcohol mixtures. The technology for these changes has already been demonstrated, on a larger scale, in the automotive industry.

Further Analysis

Because of the portable nature of this equipment, statewide implementation of any control would be beneficial for rule enforcement purposes. The District may consider pursuing such an approach with ARB or the state legislature. Also, further analysis is required to develop enforcement programs for cities banning the use of leaf-blowers.

EMISSIONS REDUCTION

The emissions from this source category are closely tied to population growth. Potential emission reductions are expected to be near 100 percent of the current emissions inventory for electrification, and 50 to 95 percent for engine modifications and oxidation catalytic controls. The use of methanol fuel would reduce ROG emissions by 50 percent.

Estimated emissions accounted from utility equipment in 1985, and projected emissions and emission reductions for the years 2000 and 2010 are presented in the summary table. Emission reductions for SO_{X} and PM are uncertain at this time and require further analysis.

COST EFFECTIVENESS

Costs vary depending on the control option. The cost effectiveness for electrifying mowers is about \$2,000 per ton of ROG (or \$200 per ton of CO). When the demand increases, the cost of electric mowers may be expected to rise.

OTHER IMPACTS

Energy conservation benefits would result from electrification, engine modifications, and the substitution of 4-stroke engines. Electrification would aid in the compliance of local noise standards. The banning of leaf blowers could have adverse effects on the gardening industry, and would increase the usage of water for outdoor cleanup.

REFERENCES

Barber, Mary. 1987. "San Marino Council Set to Pass Ordinance Banning Leaf Blowers", Los Angeles Times, Part IX, pp. 7, August 23, 1987.

Boyd, J. D. 1985. "Letter to Norm Covell, President, CAPCOA". September 11, 1985.

California Air Resources Board. 1983. Emissions Inventory on Non-Farm (MS-1), Farm (MS-2), and Lawn and Garden (Utility) (MS-3), Equipment. Status Report by Mobile Source Control Division (Standards Development Section). July, 1983.

La Jeunesse, Anne. 1987. "PVE Council Bans Use of Leafblower", <u>Peninsula News</u> (Palos Verdes), pp. 1, May 14, 1987.

McGraw, Carol. 1985. "Leaf Blowers: A Whirlwind of Controversy", <u>Los</u> <u>Angeles Times</u>, pp. 1-3, December 23, 1985.

Sears Roebuck & Co., Regional Office. 1987. Personal communication with Larry Irwin, September 1987.

Taylor, Suzanne. 1988. Leaf Blower Task Force, City of Claremont. Personal communication with Larry Irwin, January 1988.

Wallerstein, Barry. 1988. South Coast Air Quality Management District. Personal communication with Elaine Chang, March 1988.

Young, Thomas. 1987. Engine Manufacturers Association. Personal communication with Larry Irwin, September 1987.



E- AGRICULTURAL PROCESSES

Table I-2E contains the listing of the control measures proposed to reduce emissions from agricultural processes sources. Detailed description of the control measures follow this table.

TABLE I-2E TIER I CONTROL MEASURESAGRICULTURAL PROCESSES

| AQMP | CONTROL No. | TITLE |
|------|----------------|--|
| E-1 | Control | of Emissions from Pesticide Application, [ROG] |
| E-2 | Control | of Emissions from Livestock Waste, [ROG, PM, NH ₃] |
| E-3 | Control | of Fugitive Dust from Agriculture, [PM] |

CONTROL OF EMISSIONS FROM PESTICIDE APPLICATION [ROG]

<u>SUMMARY</u>

Source Category: Pesticide Application

Control Methods: Changes In Pesticide Formulation; Changes In

Pesticide Application; Changes In Timing Of Application; Alternative Control Approaches

| Emissions: (Tons/Day): | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| ROG Inventory | 5.6 | 6.9 | 7.5 |
| ROG Reduction | | 2.8 | 3.0 |

Control Cost: \$1,300 Per Ton Of ROG

DESCRIPTION OF SOURCE CATEGORY

Background

Pesticides are widely used by agricultural and commercial enterprises to control insects, fungus, animal pests, weeds and other undesirable plant growth, and many other types of pests.

Pesticide formulations consist of synthetic or nonsynthetic (petroleum based) materials which contain reactive organic compounds. Synthetic organic materials contain the toxic material used to control or mitigate the pest. Nonsynthetic organic materials are used as synergists, inhibitors, solvents, emulsifiers, wetting agents, spreaders, stickers, inhibitors, carriers, perfumes and adjuvants. Petroleum products are also diluents, carriers, perfumes and adjuvants. Petroleum products are also applied directly for the control of insects and mites on fruit trees, weeds (weed oils), and fungus on produce.

Pesticides come in many forms and are applied in a variety of ways. The forms include dust, granules, wettable powders, aerosols, emulsifiable concentrates, and oil solutions. Application methods include aircraft

spraying, ground-level spraying and sub-soil incorporation. Spray drift during application and vaporization from the surface of crops and soils are the two major routes of entry into the atmosphere.

Regulatory History

Measure C3 of the 1982 AQMP Revision addressed the control of ROG emissions from pesticide application (SCAQMD, 1982). In May 1984, the District Board approved staff's recommendation to move this measure to further study pending measure development by EPA Region IX. In the interim, EPA is developing a model rule for Fresno County Air Pollution Control District as a suggested control measure for the Technical Review Group. The model rule covers nonsynthetic herbicide applications only. The measure proposed herein is based, in part, on preliminary information made available by the EPA consultant for this suggested control measure (EPA, 1986).

PROPOSED METHOD OF CONTROL

This control measure is directed at reducing ROG emissions from the agricultural, industrial, and commercial applications of pesticides. The term pesticide is utilized in this discussion to include insecticides, fungicides, and herbicides. Domestic usage of home garden-type pesticides is not included in this proposed control measure because such products are addressed in another proposed measure titled "Control of Emissions from Domestic Products", (CM# 88-A-19). The measure addressed herein proposes changes in pesticide formulation, application, timing of application, and use of alternative control methods to reduce ROG emissions.

Due to the limited agricultural operations which take place in the District, the use of nonsynthetic herbicides, especially for weed control by commercial and industrial users, accounts for the majority (approximately 65 to 70 percent) of the total ROG emissions from pesticide application (EPA, 1981). This measure is therefore directed at herbicide use, although the proposed control techniques are also applicable for reducing ROG emissions from the other types of pesticides.

Changes in pesticide formulations include: minimizing the use of petroleum borne formulations and substituting waterborne for dry formulations where possible; adding thickening agents to increase particle size and the viscosity of the spray which in turn reduces spray drift; and substituting lower vapor pressure (higher boiling point) solvents to reduce evaporation. Another approach is substituting synthetic for nonsynthetic formulations. This last approach is seen as the most probable method to control nonsynthetic herbicide use (EPA, 1986).

Changes in application techniques include: dusting the soil with pesticides rather than spraying where reformulation is not possible; modifying the design of the spray device to prevent the formation of fine droplets during application; lowering the spray nozzle height; and

incorporating the pesticide in the soil immediately following, or in place of, spraying.

To minimize the cost impact of these controls, the use of formulation and application changes could be restricted to either the months of high ozone concentrations or days in which the ozone concentration is predicted to equal or exceed the national primary (or secondary) standard for ozone. This approach is analogous to that used to control emissions from agricultural burn operations.

Other means available to reduce ROG emissions involve relying on alternative methods to control pests. These control approaches are only available for selective applications. They include: biological control, which relies on natural enemies of the target pest; genetic control such as releasing sterile insects or breeding and developing insect resistant plants; cultural control techniques such as crop rotation and tilling open fields to prevent weed growth; and physical control methods which involve constructing physical barriers from pests. Of all of these methods, cultural control may be the most applicable for reducing nonsynthetic herbicide use (ARB, 1980).

Finally, the use of integrated pest management (IPM) can reduce the use of pesticides and therefore reduce ROG emissions. IPM makes use of all possible factors such as weather, irrigation, crop rotation, natural predators, and selection of resistant plant varieties to optimize pest control in the least environmentally harmful way.

EMISSIONS REDUCTION

During 1985, pesticide application resulted in 5.6 tons per day of ROG emissions. In the years 2000 and 2010 emissions from this source category are expected to be about 6.9 tons per day and 7.5 tons per day, respectively.

Assuming a 30 to 45 percent control efficiency for the control methods discussed above, the emissions reduction in the year 2000 will be 2.8 tons per day of ROG. The comparative reduction for the year 2010 is 3.0 tons per day. Both of these estimates are very preliminary in nature and new estimates will be made when updated data become available from EPA.

COST EFFECTIVENESS

Based on measure C3 of the 1982 AQMP, a cost effectiveness of \$1,300 per ton of ROG (in current dollars) is estimated (SCAQMD, 1982). The cost effectiveness of EPA's suggested control measure was not determined at the time of this writing. A new cost effectiveness value will be calculated when the EPA data becomes available.

OTHER IMPACTS

California law states that the California Department of Food and Agriculture (CDFA) has jurisdiction over the regulation of pesticides (Mendocino County Decision re: 2,4-D as a toxic air contaminant). California law also grants authority to local agencies to adopt rules to control sources of ROG emissions. California has also developed a detailed pesticide record keeping and regulatory system which is administered by the state and at the local levels by the County Agricultural Commissioner. Any regulation of pesticide application to control ROG emissions would need to be implemented in cooperation with, if not fully, by CDFA and County Agricultural Commissioner and would also be subject to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

REFERENCES

California Air Resources Board. 1980. <u>Final Report, Air Pollution Emissions Associated with Nonsynthetic Hydrocarbon Applications for Pesticidal Purposes in California</u>. Submitted by Eureka Laboratories, Inc. 1980.

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan, Appendix VIII-A, Measure C3, El Monte, CA. October 1982.

- U.S. Environmental Protection Agency. 1981. <u>Assessment of Tactics for Additional Emission Reductions in the South Coast Air Quality Management District</u>, California. Submitted by Engineering Science. 1981.
- U.S. Environmental Protection Agency Region IX. 1986. Personal Communication with Linda Basilio. 1986.

CONTROL OF EMISSIONS FROM LIVESTOCK WASTE [ROG, PM, NH₃]

SUMMARY

Source Category: Livestock Waste

Requiring Alternative Uses; Requiring Alternative Control Methods: Disposal Methods; Addition Of Water To Compost

Piles; And Better Housekeeping Procedures

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| ROG Inventory | 37.9 | 39.4 | 40.6 |
| ROG Reduction | | 9.8 | 10.1 |
| PM Inventory | 0.7 | 0.7 | 0.7 |
| PM Reduction | | 0.3 | 0.4 |
| NH ₃ Inventory | 94.0 | 94.0 | 94.0 |
| NH ₃ Reduction | 23.0 | 23.0 | 23.0 |

Control Cost: \$1,700 Per Ton of ROG

Other Impacts: Reduction of Ammonia Emission May Increase Acid

Deposition In Riverside/San Bernardino; Addition Of

Water To Compost May Exacerbate Existing Water

Quality Problem In The Chino Area

DESCRIPTION OF SOURCE CATEGORY

Background

Wastes from livestock contribute to several different air pollution problems. Livestock includes dairy and beef cattle, horses, pigs, sheep, chicken and other poultry. Liquid wastes and decomposing manure release volatile organic compounds (primarily methane and ethane) and ammonia into the atmosphere (EPA, 1980). Ethane can act as a precursor for the formation of ozone and other photochemical pollutants, and ammonia can contribute to the formation of particulate nitrate and sulfate. addition, the handling and the composting of the solid animal manure results in emissions of dust (PM).

In the entire Basin, there are approximately 500,000 dairy animals that produce a total of about 620,000 tons of solid waste each year. The majority of livestock waste (approximately 75 percent) generated in the Basin is associated with dairy and other agricultural operations in the greater Chino area. Urban sprawl in the Basin, along with increased demands for meat, milk, and animal products, has resulted in one of the largest concentrations of dairy livestock in the world. Approximately 380,000 cows, heifers, and calves support 350 dairies in the Chino area. Other agricultural operations in this area also maintain livestock. Cumulatively, these operations produce approximately 475,000 tons of manure per year (San Bernardino County Land Management Department, 1985).

Dairy cattle populations are expected to increase in concentration in the future despite the fact that the number of dairy farms is decreasing (San Bernardino County Planning Department, 1982). As housing developments replace some of the dairy farms, the displaced operators sell their dairy herds to the remaining farmers. The result is that dairy operations are becoming more intensive. The portion of a dairy taken up by corrals is increasing and there is less land remaining for pastures and crops (i.e. land on which to spread manure). It is estimated that the amount of manure the farmers will be able to spread on their land could decrease by ten percent in five years.

Regulatory History

Livestock waste in the Chino area has contributed significantly to the degradation of water quality in the Santa Ana Watershed Basin. Over time, the spread of solid and liquid wastes, combined with the rainfall runoff from these wastes, has increased the soil salinity and added to the buildup of nitrates and dissolved solids in ground water. To mitigate this problem, the Santa Ana Regional Water Quality Control Board (the regulatory agency responsible for water quality control for the Chino area) has established strict discharge requirements for livestock operators and composters (SARWQCB, 1986).

To meet these requirements, the liquid waste from cattle and the runoff from the solid manure are generally collected in ponds where they are allowed to vaporize to the atmosphere. To control the solid manure, livestock operators contract with neighboring farms or compost operations to collect and remove these wastes. Dairy corrals are typically cleaned out twice a year: in the spring after the corrals dry out and in the fall before the winter rains. The wastes are either spread out over the land or transported to compost operations where they are piled in open fields and allowed to convert aerobically to compost. Some of this compost is then sold to nearby farmers, but the majority of it is packaged and sold as soil amendments (e.g. potting soil and fertilizer) to home gardeners, landscaping firms, and commercial farming operations.

PROPOSED METHOD OF CONTROL

The following five proposed methods of control are oriented toward reducing emissions of reactive organic gases, ammonia, and particulate matter. Several of these proposals are based on methods which have been suggested by the Santa Ana Regional Water Quality Control Board to mitigate the adverse water quality impacts from livestock waste in the Chino area (SARWQCB).

Housekeeping Measures

In order to reduce emissions of reactive organic gases and ammonia, it is necessary to promote aerobic rather than anaerobic conditions in the animal feed yard floors, runoff holding ponds, and manure stockpiles. Good housekeeping procedures effectively encourage aerobic conditions. Such procedures include at a minimum:

o Feed yard

- Requiring the removal of the surface layer of manure from the feed yards, scarification of the yards, and cleaning of the dairy corrals at least three times a year.
- Requiring the scarified ground to be sprayed with 1 percent solution of $KMnO_4$ three times a year so that treatments amount to 60 lb. $KMnO_4$ per acre per year.
- Requiring the drainage of excess moisture from the yards (slope = 2 to 4 percent).

o Runoff Holding Ponds

- Requiring the removal of solids from runoff.
- Requiring the aeration of ponds.

o Manure Stockpiles Located on the Farm

- Requiring the stockpiling of manure in long, narrow windrows 4 to 6 feet high.
- Requiring the aeration of windrows by turning every 3 to 7 days or by injecting air using perforated pipe.
- Requiring the crowning of windrows.

Watering of Composting Operations

Windblown dust from compost operations can be controlled through the addition of water or other binders to suppress the dispersion of particles

into the air. Other mitigation measures include constructing physical barriers to contain the windblown compost.

Hauling

In the past, alfalfa farmers from the desert hauled a significant amount of manure out of the Basin on their return trips from market. This practice has waned recently as they have found that it is no longer economical. However, it has been suggested that numerous alfalfa farmers exist along the Mojave River that could be encouraged to use the manure generated from livestock in the Basin (San Bernardino County Planning Department, 1986). To reduce emissions, the collection would take place more frequently than twice a year, and transportation would be in a covered truck.

Sewage Treatment

Another alternative disposal method would be to slurry the liquid wastes to a local sewage treatment facility. The volume of wastes generated in the Chino area, however, would require construction of new treatment facilities (SARWQCB, 1986). This alternative is currently being investigated by the U.S.D.A. Soil Conservation Service.

Anaerobic Digestors

Dairy waste could be used to derive energy through the use of anaerobic digestors. This technology is feasible and has been demonstrated in several pilot tests using wastes generated from dairies and other livestock operations (Klass, 1981). This technology relies on the fermentation of manure within enclosed tanks to produce methane, the principal component of natural gas. The methane produced could be used by the dairies or sold to public utilities. For this technology to be effective in reducing organic and ammonia emissions, the wastes would have to be collected and removed for digestion more frequently. One experiment with dairy manure showed that digestors produced 2.3 times as much gas using fresh manure containing its original moisture as using aged manure (Robinson, 1980). Moreover, the use of waste to derive energy would replace composting operations and the particulate matter associated with this activity.

At the present time, a subsidiary of American Diversified Capital Corporation of Costa Mesa, CA is under contract with Southern California Edison to build a large anaerobic digestor that would utilize animal waste to produce electricity (Southern California Gas Co., 1986). The digestor, which will produce about 25 MW of electricity, will handle over 740 dry tons of local animal waste each day. Since the manure must be fresh, the company will collect the waste (at no cost to the farmer) at least once emissions of reactive organic gases, ammonia, and paticulate matter. The proposed digestor will dispose of its waste effluent by feeding it into an existing industrial waste pipeline, the Santa Ana Regional Interceptor, which will transport it to a waste treatment facility in Orange County.

EMISSIONS REDUCTION

In 1985, ROG and PM emissions from livestock waste were 37.9 and 0.7 tons per day, respectively. Ammonia emissions from livestock waste in 1982 were estimated to be 94 tons per day out of a total of 181 tons per day (Russell and Cass). Estimates for the year 2000 are 39.4 tons per day of ROG and 0.7 tons per day of PM. In the year 2010, emissions are expected to be 40.6 tons per day of ROG and 0.7 tons per day of PM. No forecast has been made of ammonia emissions; future emissions are assumed to equal current emissions.

Estimates have also been made for the emissions reduction for each of the proposed control strategies. Watering the compost piles would result in a 50 percent reduction of directly emitted particulate matter. The improved housekeeping procedures would reduce ROG emissions by 20 percent, particulate matter by 7 percent, and ammonia by 20 percent. Hauling manure out of the Basin would result in reductions of 11.5 percent for ROG, 5 percent for particulate matter, and 10 percent for ammonia. Estimates for emissions reductions from the anaerobic digestor are 40 percent of ROG, 90 percent for particulate matter, and 40 percent for ammonia. The overall range for ROG is 10 to 40 percent control, for ammonia 10 to 40 percent control, and for PM 5 to 90 percent control. Therefore, the future emissions reduction potentials are 9.8 and 10.1 tons per day for ROG, 0.3 and 0.4 tons per day for PM, and 23 tons per day for ammonia in the years 2000 and 2010, respectively.

COST EFFECTIVENESS

In the Basin, the annual costs of housekeeping (i.e., using potassium permanganate, scraping the corral, cleaning run-offs, aerating windrows) will be \$5,000,000; watering composite piles, \$160,000; and hauling to the desert, \$1,000,000. Therefore, total annual costs will be \$6.2 millions. Since 10 tons of ROG are reduced daily, 3,650 tons of ROG are reduced annually. Hence, the cost of control becomes \$1,700 per ton of ROG reduced.

At an anerobic digester facility, besides earning income from selling digester gas to utilities, the operator of the digester may charge dairy farmers for their livestock waste instead of paying for the digester's "raw material". If the prices charged are lower than current waste disposal costs, the dairy farmers could end up saving money.

OTHER IMPACTS

The alternative uses and disposal methods proposed herein would mitigate much of the water quality degradation in the Santa Ana Watershed Basin. However, the addition of water to suppress windblown dust may offset some of these benefits. Water application must be carefully regulated so that it does not leach pollutants into the ground water.

Potassium permanganate ($KMnO_4$) oxidizes those compounds that cause odors. Therefore, its application will reduce unpleasant odors emanating from dairy operations.

Ammonia emissions from wastes in the Chino area may counteract and neutralize nitric and sulfuric acids in rain water in the eastern portion of the Basin. Removing these emissions, therefore, may result in higher acidity levels (lower pH readings) and damage from acid rain, acid fogs, and dry deposition.

Anaerobic digestors emit hydrogen sulfide (H_2S) , a byproduct of the fermentation process. Scrubbers or other techniques would be required to scurb these emissions (Robinson, 1980).

The implementation of this measure is within the jurisdiction of the District. However, the alternative uses and disposal methods for livestock waste described in this measure are already being investigated by the Santa Ana Regional Water Quality Control Board and other local agencies. These agencies have adopted and implemented an extensive regulatory program to mitigate and control the impacts of wastes and their composting. Any further regulation to control these wastes for purposes of mitigating air emissions should be pursued in cooperation with these agencies.

REFERENCES

American Diversified Capital Corporation. 1986. Personal Communication with Barry Wallerstein, 1986.

Klass, D.L. and G. Emert. 1981. <u>Fuels From Biomass and Wastes</u>. Ann Arbor, MI.

Robinson, J.S., ed. 1980. <u>Fuels From Biomass, Technology and Feasibility</u>. Park Ridge, N.J.

Russell, A.G., and G. Cass, ed. 1987. <u>Formation and Control of Nitrogen-Containing Air Pollutants</u>. EQL Report 24, Environmental Quality Laboratory, California Institute of Technology. May 1987.

San Bernardino County Land Management Department. 1985. <u>Chino Agricultural Preserve Study</u>. San Bernardino, CA.

San Bernardino County Planning Department. 1982. <u>San Bernardino Dairy</u> Study, San Bernardino, CA.

San Bernardino County Planning Department. 1986. Personal Communication with Barry Wallerstein. 1986.

Santa Ana Regional Water Quality Control District. 1986. Personal Communication with Barry Wallerstein. 1986.

Southern California Gas Co. 1986. Personal Communication with Barry Wallerstein. 1986.

U.S. Environmental Protection Agency. 1980. <u>Volatile Organic Compound Species Data Manual</u>. Second Edition. PB81-119459, Research Triangle Park, N.C. 1980.

CONTROL OF FUGITIVE DUST FROM AGRICULTURE [PM]

<u>SUMMARY</u>

Source Category: Wind Blown Dust From Agricultural Areas

Control Methods: Windbreaks; Soil Stabilization; Asphalt Cover;

Different Agricultural Practices; And Wet

Suppression

Emissions:
(Tons/Day)

Year 1985

Year 2000

Year 2010

PM Inventory
PM Reduction

8.0

Not Determined

Control Cost: Not Determined

Other Impacts: Not Determined

DESCRIPTION OF SOURCE CATEGORY

Background

Agricultural operations produce fugitive dust emissions which contribut to PM concentrations. Agricultural areas are located predominantly in th eastern portion of the Basin where PM concentrations are the highest Agricultural fugitive dust is created from tilling operations, harvesting cultivation, use of unpaved farm roads and from wind erosion of the soi surface of fields and unpaved farm roads. Wind erosion of the soil surfac is not just an air quality problem, but is a significant cause of degrade soil quality.

Regulatory History

District Rule 403 (Fugitive Dust) prohibits visible amounts of fugitive dust from being emitted but specifically exempts agricultural operations.

PROPOSED METHOD OF CONTROL

The proposed control is directed toward reduction of PM emissions from agricultural areas. A great variety of methods for reducing agricultural fugitive dust have been thoroughly studied, especially in the midwestern states, and many have been implemented. Methods which may be useful include: vegetable cover, asphalt cover, improved tillage practices, windbreaks, closer crop spacing, and limited irrigation of fallow fields. For unpaved farm roads methods include: wet suppression, chemical stabilization, physical stabilization, and windbreaks.

The method or methods which would be most appropriate for a given location depend on many factors, among them being the crop, type of soil, meteorological conditions, field relief and orientation, condition of the surrounding belt (trees and structures), and irrigation practices.

EMISSIONS REDUCTION

Particulate matter emissions from agricultural tilling operations were estimated to be 8 tons per day in the years 1985 through 2010; this is approximately 0.4 percent of the total directly emitted particulate matter in the Basin. There are no PM emission estimates for harvesting, cultivation, and wind erosion of fields and unpaved roads. Emissions estimates were made with an assumed soil silt content of 18 percent; actual silt content is unknown and can be expected to vary greatly. Receptor modeling of primary emission sources indicates that soil sources contribute at least 5 percent of the annual average PM concentrations at Rubidoux.

COST EFFECTIVENESS

No cost data is currently available for this measure.

OTHER IMPACTS

No significant adverse impacts of this measure are known or anticipated. No estimate of the impact of this measure can be made at this time because of the absence of specific information on the many variables affecting the generation of agricultural fugitive dust. A detailed study of agricultural fugitive dust in the Basin will be needed to identify which methods of control are most appropriate for the variety of locations, soils, and agricultural processes involved.

REFERENCES

Bocharov, A. 1984. <u>A Description of Devices Used in the Study of Wind Erosion of Soils</u>. V. I. Lenin All-Union Academy of Agricultural Sciences, translated from Russian for the U. S. Department of Agriculture and the

National Science Foundation. Published by Amerind Publishing Co. Pv Ltd., New Delhi, TT78-52013. 1984.

Cuscino, J., et al., 1981. <u>The Role of Agricultural Practices in Fugiti Dust Emissions</u>. Midwest Research Institute, prepared for the Californ Air Resources Board, PB81-219073. June 1981.

F- OTHERS

The control measures proposed for reducing emissions from other stationary sources are listed in Table I-2F. Detailed description of the control measures for each of these sources are described in the following section.

TABLE I-2F TIER I CONTROL MEASURESOTHERS

| AQMP | CONTROL No. | TITLE |
|------|----------------|---|
| F-1 | | Installation of Best Available Retrofit Control Technology, [All Pollutants] |
| F-2 | | Uniform Commercial Quality Standard on Sulfur Content of Gaseous Fuels, [SO _X] |
| F-3 | | Lower Limits on Sulfur Content of Stationary Liquid Fuels, $[SO_X]$ |
| F-4 | | Control of Fugitive Emissions from Construction of Roads and Buildings, [PM] |
| F-5 | | Control of Ammonia Emissions from Stationary Sources by Permits and Fees, $[\mathrm{NH}_3]$ |
| F-6* | | Control of Emissions from Exempt Equipment, [All Pollutants] |
| F-7* | | Control of Emissions from Soil Decontamination, [ROG] |
| F-8* | | New Source Review, [All Pollutants] |
| F-9 | | Low Emission Method and Materials for Building Construction, [ROG, PM] |
| F-10 | | Phase-Out Stationary Source Fuel Oil and Solid Fossil Fuel Use, $[\mathrm{NO_X},\ \mathrm{PM},\ \mathrm{SO_X}]$ |

INSTALLATION OF BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY [ALL POLLUTANTS]

SUMMARY

Source Category: All Permitted Stationary Sources

Control Methods: Require Best Available Retrofit Control Technology

(BARCT) on Existing Permitted Sources

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | 208.0 | 218.0 | 230.0 |
| ROG Reduction | | 51.0 | 54.0 |
| NO_X Inventory NO_X Reduction | 49.0 | 58.0 12.0 | 65.0 13.0 |
| SO_X Inventory SO_X Reduction | 16.0 | 18.0 4.0 | 19.0 4.0 |
| PM Inventory | 32.0 | 30.0 | 35.0 |
| PM Reduction | | 6.0 | 7.0 |
| CO Inventory | 58.0 | 70.0 | 78.0 |
| CO Reduction | | 13.0 | 15.0 |

Control Cost (maximum - see text): \$17,500 Per Ton of ROG \$24,500 Per Ton of NO_X \$18,300 Per Ton of SO_X \$5,300 Per Ton of PM

DESCRIPTION OF SOURCE CATEGORY

Background

Under current District rules, once the operator of a source has a permit to construct the operator is not required to install additional emissions control technology or otherwise revise the process using technology that

may subsequently become feasible for installation on a retrofit basis unless required by a specific District rule. Within the District there are many pieces of permitted equipment that are operating with a level of control technology less stringent than would be required for new equipment permitted today. The majority of these sources are in the medium to small emission source categories; many sources that would be regarded as relatively unique.

Although many sources have the potential for reduction by installing newer technology that is lower emitting, rulemaking efforts have not focused on many of these sources because source-by-source rulemaking to require the installation of retrofit control technology would consume limited District staff resources for rules with relatively small emission reductions.

Regulatory History

SB 151 (Presley) effective January 1988 requires the District board to adopt rules and regulations to require the use of best available retrofit control technology (BARCT) on existing sources.

PROPOSED METHOD OF CONTROL

Three alternative methods to overcome the resource constraint on reducing excess emissions are discussed. It is assumed that BARCT would be developed to consider both criteria and toxic emission sources.

Alternative 1

This method would require by District rule the installation of BARCT within some time period after BARCT for that equipment category is established by District staff. Permits for the affected equipment would be renewed at that time. Cost guidelines could be established by the Board to avoid excessive costs being imposed in unusual cases.

Alternative 2

This method would require by District rule that all permits be renewed every five years and that renewal of the permit be contingent upon the installation of BARCT. BARCT for each equipment category would be established annually by staff with board approval. All permits at a facility would be renewed every five years. To the extent that costs and emissions reductions can be estimated for BARCT, this information can be presented to the Board for their consideration as part of the annual cost effectiveness to be applied.

Alternative 3

This method would establish BARCT by individual District rules. Cost information would be developed for each application of BARCT included in

the rule. This approach would require an expanded District Rule Development effort.

EMISSIONS REDUCTIONS

The District has estimated the emissions reductions that could be achieved from the installation of BARCT on permitted sources which are not affected by other short range control measures included in this report. These estimates are listed below. Additional emissions reductions could be expected from a BARCT program as new retrofit control technology becomes feasible and is adopted as BARCT.

| | ROG | Pollutan NO _X | t (Tons/Day) SO _X | CO | PM |
|--------------|----------|-----------------------------|---------------------------------|----------|-----|
| 2000 2010 | 51 54 | 12 13 | 4 | 13 15 | 6 7 |

COST EFFECTIVENESS

The cost effectiveness of this measure would depend on the cost criteria scenario adopted by the Board for use in applying BARCT. Assuming that the upper limit of cost effectiveness criteria currently being used were applied to these sources, the cost effectiveness for each emittant is:

| ROG | \$17,500/ton |
|-----------------|--------------|
| NO _X | \$24,500/ton |
| SO _X | \$18,300/ton |
| PM^ | \$5,300/ton |

OTHER IMPACTS

Other impacts will depend on the control technology adopted as BARCT. To the extent that BARCT considers toxic as well as criteria emission sources, this measure could also reduce toxic emissions and associated health impacts. In all three alternatives listed above, significant additional District staff resources would be required to administer the program.

10

UNIFORM COMMERCIAL QUALITY STANDARD ON ALL GASEOUS FUELS [SO_x]

<u>SUMMARY</u>

Source Category: Gaseous Fuels

Control Methods: Amine Treatment; Merox Process; Ferrous and

Ferric Chloride Precipitation; Stretford Process

or Other to Achieve 100 ppm Sulfur Limit

| Emissions: (Tons/Day) | | <u>Year 1985</u> | <u>Year 2000</u> | Year 201 |
|--|---------------------------------|---|--|--|
| SO _X Inve SO _X Redu | ntory ction | 3.6 | 2.3 1.4 | 2.3 1.4 |
| Control Cost: | <u>Refiner</u> Amir | <u>ry Gas</u> ne Treatment | \$13,000 Per Ton | of SO _X |
| | Digeste FeCL Stre Caus | er Gas 2-FeCl ₃ Treatment tford Process tic Scrubbing | \$49,000 Per Ton \$35,000 Per Ton \$20,000 Per Ton | of SO _X of SO _X of SO _X |

DESCRIPTION OF SOURCE CATEGORY

Background

Petroleum refining and solid waste decomposition both generate fuel gases. Some of the gases generated contain relatively high concentrations of sulfur, especially in the form of hydrogen sulfide and mercaptans. Gases containing a high sulfur concentration are generally referred to as "sour gases", since some of the sulfur-containing compounds have a noxious odor and are acidic. The sulfur concentration of these gases can be reduced to eliminate noxious odors and to minimize the emissions of sulfur oxides. This process is referred to as "sweetening" the gas.

Regulatory History

District Rule 431.1 sets limits on the sulfur concentration of gaseous fuels used or sold in the South Coast Air Basin. The most stringent limit which has been established, 80 ppm of sulfur, applies to gaseous fuels other than landfill or sewage digester gas which are sold. For landfill and sewage digester gas, a 250 ppm sulfur limit has been established. Fuels meeting either the 80 or 250 ppm standard are considered "commercial quality," since they can be introduced into the commercial delivery system without further treatment. Other gaseous fuels which are used on-site are allowed an 800 ppm sulfur limit. Most of this fuel is refinery gas which is burned in boilers and heaters. Compliance with each of the above limits is on the basis of measured total sulfur calculated as hydrogen sulfide.

In April 1983, the District staff considered but rejected the concept of establishing a uniform commercial quality standard for gaseous fuels. The District staff now believes that a uniform commercial quality standard can be achieved through the use of existing sulfur control technologies. This measure proposes to establish such a standard to reduce sulfur dioxide emissions and the formation of secondary sulfates in the atmosphere.

PROPOSED METHOD OF CONTROL

A large variety of techniques exists for sweetening gaseous fuels generated at refineries, landfills, and sewage treatment plants. Most of these techniques have been in use for many years and are well proven. By careful selection and improved use of these methods, gaseous fuels may meet a maximum sulfur limit of 100 ppm before dilution. Selection among available techniques will be based on the sulfur concentration of the sour gas, type of sulfur compounds to be removed, total amount of gas to be treated, and other facility specific parameters such as land availability and cost.

Refineries

In refinery operations, sour gas treating is generally carried out in a packed or tray tower. A sulfur-extracting agent is introduced at the top of the tower and flows downward by gravity. The sour gas enters at the bottom of the tower and counterflows upward. As the gas and extracting agent commingle in the tower, the agent selectively captures targeted sulfur compounds. The captured sulfur compound is either stripped from the sulfur agent and further treated separately, or the agent and bonded sulfur compound further treated together, before disposal.

Hydrogen sulfide and mercaptans are the predominant sulfur compounds in gaseous fuels produced in refineries. Most refineries utilize an amine treatment process to decrease the hydrogen sulfide concentration in fuel gas streams. Merox treatment, and others, are available for mercaptan removal.

o Hydrogen Sulfide Removal

Amine treatment involves a single absorption/regeneration cycle circulating an aqueous amine solution which strips hydrogen sulfide from the sour gas. The captured hydrogen sulfide is subsequently steam stripped from the solution and sent to the sulfur recovery plant for conversion and removal and may also remove small amounts of mercaptans.

o Mercaptan Removal

The Merox process can be employed as a primary treatment or as a follow-up to capture the mercaptans from the sour gas. The mercaptan-bearing alkali solution undergoes subsequent air oxidation to yield disulfides, regenerated catalyst, and renewed alkali solution. The disulfides are then fed to a catalytic cracker or other refinery unit and sulfur-containing gases generated ultimately treated in the sulfur recovery plant. By using the Merox process, the mercaptan concentration can be reduced by 90 percent or more.

Sewage Treatment Plants

Since odor control is an important operating consideration for sewage treatment plants, these facilities have utilized gas treatment techniques for many years to reduce hydrogen sulfide emissions. Ferrous chloride injection was the first method employed to control odors. The ferrous chloride precipitates iron sulfides which remain in the sludge. This precipitation reaction is quicker than the hydrogen sulfide formation reaction and thus limits the formation of hydrogen sulfide gas. The iron sulfides intermix within the residue sludge which is dewatered and sent to a compost pile or landfill, or is used as fuel in a fluidized bed combustor.

Ferric chloride injection is also used to control odors. It not only keeps the sulfur compounds in the sludge like the ferrous chloride, but also dissolves the struvite, $MgNH_4PO_4$, which can interfere with the flow of the liquid in the pipes.

Both the ferrous and ferric chloride precipitation methods are now the lowest cost technique for achieving the existing 250 ppm limit for digester gas. In fact, some treatment plants are now producing gas with less than 100 ppm sulfur content by these methods. The drawback to these methods, however, is the disposal of solid iron sulfates (or when the sludge is used as fuel, iron oxides) to landfill sites. In addition, there are occasions that the SO_{χ} level may exceed 100 ppm, but the average concentration is generally less than 100 ppm. Therefore, treatment plants that cannot meet the proposed limit by chemical injection alone may have to rely on the transfer of technology already proven in other applications. Alternatives include the following:

- The Stretford process is one transferable technique that is used effectively in refineries to remove hydrogen sulfide from the gas. This process relies on an aqueous solution of sodium carbonate, sodium metavanadate and anthraquinone, 3,7-disulfonic acid to absorb the hydrogen sulfide from the digester gas. This process requires higher capital cost but lower operating cost.
- Caustic scrubbing is another technique used by oil-field gas production to obtain a commercial quality of gas. This process involves a controlled contact between the sour gas and caustic solution of sodium hydroxide. The reaction of the caustic with hydrogen sulfide is quicker than with carbon dioxide. Therefore, with a controlled contact time, carbon dioxide may not interfere with the reaction. In oil field production, the spent caustic is injected underground. In sewage treatment plants, the spent caustic will have to be disposed of properly. One facility is considering this measure to treat the residual H₂S left in the digester gas. This facility, however, is concerned about any possible damage the sodium may cause in its turbines. Additional processing, such as a chiller, is needed to remove any sodium left in the sweet gas.

Landfills

The fuel gas generated at most landfills is already within or below the proposed 100 ppm maximum sulfur limit. For some facilities, however, there may be a need to perform limited gas treatment. Presumably this will also be accomplished through a transfer of technology such as caustic scrubbing.

EMISSIONS REDUCTION

The proposed 100 ppm uniform standard will reduce the average sulfur concentration of refinery gas (i.e., 250 ppm) by 60 percent and the average concentration of sewage digester gas (i.e., 250 ppm) by approximately 60 to 68 percent. It will also provide a cap on SO_{X} emissions from the burning of landfill gas.

The total ${\rm SO}_{\rm X}$ emissions in 1985 was about 3.6 tons per day. This is based on the average consumption of 18.1 million equivalent barrels of refinery gas with 2150 ppm H₂S and the generation of 17 million cubic feet per day of sewage digester gas. In the years 2000 and 2010, ${\rm SO}_{\rm X}$ emissions from this source category are estimated to be 2.3 tons per day. The emissions reduction potential for the above years are 1.4 tons per day.

COST EFFECTIVENESS

Some refineries are now producing fuel gas below the proposed limit, and as such, no additional control is necessary for compliance. Other refineries, however, need to install amine units to comply with the limit at a cost of about \$13,000 per ton of SO_{X} reduced.

The digester gas treatment with ferrous and ferric chloride to reduce the sulfur content to 100 ppm would cost about \$49,000 per ton. The Stretford unit may reduce the sulfur in the gas to well below 100 ppm at a cost of \$35,000 per ton, and the caustic process costs about \$20,000 per ton of SO_{X} reduced.

OTHER IMPACTS

There will likely be increased solid and liquid waste which will have to be disposed of properly.

LOWER LIMITS ON SULFUR CONTENT OF STATIONARY LIQUID FUELS $[S0_{Y}]$

SUMMARY

Source Category: Liquid Fuels

Hydrodesulfurization; Blending; and Modification Control Methods:

of Crude Slates.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| SO _x Inventory | 13.6 | 12.9 | 13.5 |
| SO _x Reduction | | 4.3 | 4.5 |

Control Cost: \$25,000 Per Ton of SOx

Other Impacts: Increased Fuel Costs; Increased Liquid/Solid Waste

Materials

DESCRIPTION OF SOURCE CATEGORY

Background

This control measure is directed at reducing SO_X emissions from stationary sources through the use of low-sulfur liquid fuels. There are two ways to reduce SO_X emissions from stationary source liquid fuel combustion. One method is to reduce the sulfur content of the fuel; the other is to treat the combustion gas. Regulation of the fuel content has been effectively used to reduce SO_X emissions from both stationary and mobile sources.

Regulatory History

Current District limits on sulfur concentration of liquid fuels sold or burned in the South Coast Basin are contained in Rule 431.2. The limits are as follows: 0.05 percent by weight for diesel fuel; 0.25 percent by weight for fuel burned in a steam generator at a power plant or for refinery equipment; and 0.50 percent by weight for all other fuel burned by stationary sources. In addition, Rule 431.2 contains an equivalency provision which allows the use of higher sulfur fuel if the stack emissions are reduced to a level equal to burning the prescribed fuel.

The stringent 0.05 percent specification for diesel fuel was adopted in 1985 to provide consistency with California Air Resources Board motor vehicle fuel specifications. Previous to this action, a 0.50 percent by weight limit was generally applicable to diesel fuel burned in stationary sources.

Control Measure E5 in the 1982 AQMP proposed reducing the sulfur concentration of liquid fuels burned in utilities from 0.25 to 0.10 percent by weight. Rulemaking for this measure was scheduled to occur in 1985, but was delayed to allow for further investigation. Periodic analysis of this proposal has indicated that a 0.10 percent specification is technologically feasible. Measure E5 is therefore reintroduced here and expanded to include the specification of more stringent limits for other distillate and residual fuels burned in stationary sources.

PROPOSED METHOD OF CONTROL

Preliminary analysis by the District staff shows that the following lower limits for sulfur concentration of liquid fuels are feasible:

- 0 0.05 percent by weight for all distillate fuels;
- 0.10 percent by weight for residual fuels burned in power plants and refinery equipment; and
- 0 0.25 percent by weight for residual fuels burned in industrial boilers and heaters.

Implementation of the above limits is expected to result in the following: First, it will lower emissions from sources which currently burn liquid fuels and, second, it will provide a safeguard in case there is switching from natural gas to liquid fuels. The latter is important since consumers prefer to burn natural gas and SO_{X} emissions from natural gas combustion are very low.

There are different methods available to reduce the sulfur content of stationary source distillate and residual fuels. These include hydrodesulfurization, blending, and modification of crude slates. Each of these is a fuel modification technique applied by the refiner rather than the end user. Therefore, each refiner will decide for itself whether a particular fuel market in the District merits the production and sale of low sulfur fuels. Some different methods available to meet more stringent sulfur limits are:

o Hydrodesulfurization which utilizes a hydrogenation reaction in the presence of a desulfurizing catalyst to react hydrogen with the sulfur-containing hydrocarbons (i.e., the liquid fuel). The degree

of desulfurization is controlled by the type and amount of catalyst and other reaction parameters such as temperature and pressure. This technique is already utilized in refineries to meet current limits. More stringent limits will necessitate enhancement of current hydrodesulfurization capacity and will probably require the installation of additional hydrogen plants and sulfur recovery units. The need for additional equipment is refinery specific and varies with product slate.

- Blending can be used to produce low sulfur fuels. In this approach, a portion of the product is treated beneath the specification and blended with a higher sulfur product to reach the desired sulfur concentration. This can help minimize the amount of product which must be hydrotreated.
- Switching to lower sulfur crudes, such as Saudi Arabian Light. Such an action reduces the amount of hydrotreating which is necessary to meet more stringent specifications, reducing the need for additional equipment. Utilization of this option would compliment both of the other two options.
- If a low-sulfur fuel is not available, an equivalent measure can be employed. For example, flue gas desulfurization techniques can be used with a high-sulfur fuel to remove SO_{X} so that emissions are equal to that which would occur with liquid fuel that meets the limit.

EMISSIONS REDUCTION

Stationary source combustion of distillate (not including diesel) and residual fuels resulted in approximately 13.6 tons per day of SO_X in 1985. In the years 2000 and 2010 emissions are expected to be 12.9 and 13.5 tons per day, respectively

A preliminary estimate of the emission reduction potential of this measure is about 33 percent or 4.3 tons per day of SO_{X} in the year 2000. The comparable SO_{X} reduction for the year 2010 is 4.5 tons per day.

COST EFFECTIVENESS

Preliminary investigation shows that the capital investment for a hydrodesulfurization (HDS) unit is about \$2.75 million per 1000 bbl. of feed. Assuming that the production capability for 0.25 percent sulfur fuel is already available, the only treating capacity needed will be to comply with the 0.1 percent sulfur limit. The addition of this capacity would result in a cost effectiveness of about \$25,000 per ton of SO_{X} reduced.

OTHER IMPACTS

If implemented, this measure could result in higher refining costs for liquid fuels sold in the Basin. The incremental increase in cost could most likely be passed on to local fuel purchasers at a rate of up to 25 cents per gallon. This increase could result in a corresponding increase in natural gas prices.

Implementations of this measure will also likely increase solid and liquid waste disposal by affected refineries.

CONTROL OF FUGITIVE EMISSIONS FROM CONSTRUCTION OF ROADS AND BUILDING [PM]

<u>SUMMARY</u>

Source Category: Road and Building Construction Sites

Control Methods: Watering; Chemical Treatment

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| PM Inventory | 195.0 | 260.0 | 292.0 |
| PM Reduction | | 130.0 | 146.0 |

Control Cost: \$9,300 Per Ton of PM

DESCRIPTION OF SOURCE CATEGORY

Background

Construction and demolition of buildings and roads which disturb the soil or destroy building materials result in dust emissions and Particular matters (PM) in the air that have a substantial impact on air quality. Dust emissions are generated by such activities as land clearing, blasting, ground excavation, cut and fill operations, and travel on the site and its access roads. Wind erosion of the unprotected soil is also of concern. So is water erosion; truck and heavy equipment tires, which transport the soil onto sidewalks and roadways, where pedestrians and vehicles generate fugitive dust resuspention. This source of road dust contributes to paved roads PM emissions as well. Emissions vary with the level of activity, roads PM emissions as well. Emissions vary with the prevailing weather conditions (Evans, 1980).

Regulatory History

Presently, Los Angeles, Orange, Riverside, and San Bernardino Counties, and municipalities therein require some form of dust control at construction

sites. This can take the form of watering the sites, using a chemical soil binder, or constructing wind barriers. However, the most frequently employed method of control is watering since water and the necessary equipment are usually available at construction sites. Although each county and/or city has its own enforcement division, dust abatement requirements generally are only enforced when a nuisance complaint is made.

This control measure was referenced in the Short-Range Control Measures' Appendices which documented those measures that are under development for the 1987 revision to the Air Quality Management Plan. This measure was directed at reducing fugitive PM emissions from building and road construction, and proposed watering as its sole method of control. It underwent further research to identify additional sources and methods of control associated with construction activities, and was developed into the present control measure.

PROPOSED METHOD OF CONTROL

For reducing dust emissions during construction, the control method with the highest control efficiency is watering. However, the amount of water applied will be dependent upon the specific operation, the type of soil at the site, and the site's exposure to wind. Therefore, it is required that a strict watering schedule, drawn up by a soil engineer, be followed at each site. The plan should be initiated such that a crust will be formed on the ground surface to reduce the amount of fugitive dust. Also, soil shall be premoistened prior to grading, and the site shall be watered at the end of the day.

The following guidelines shall be adopted by the crew at the construcion site:

- Where appropriate, roads on construction sites will be paved as soon as possible.
- All grading activities will be ceased during periods of high wind (i.e. greater than 30 MPH).
- o Trucks hauling soil, dirt, sand, or other emissive materials are required to cover their loads.

Immediately after construction and initial landscaping are finished, the soil should be treated with chemical soil and dust binders, followed by seeding and watering.

An effective watering program, twice daily watering with complete coverage, is expected to reduce dust emissions by up to 50 percent. However, the need for frequent application creates an increased demand on a limited resource. While water suppression is still a variable control method, additional methods have been identified to supplement its use in reducing fugitive dust emissions. These methods are as follows: encouraging

developers to maintain the natural topography to the extent possible to eliminate the need for extensive land clearing, blasting, ground excavation, grading and cut and fill operations; and requiring the installation of truck wheel washers and other types of barriers at construction sites to prevent the transport of soil onto public rights-of-way.

FMISSIONS REDUCTION

It is estimated that building and road construction sites in the Basin emitted approximately 195.0 tons per day of PM in 1985. In the years 2000 and 2010 emissions from this source catagory are expected to grow to 260.0 and 292.0 tons per day, respectively.

An effective watering program supplemented by limiting some construction activities on windy days is estimated to reduce PM emissions by up to 50 percent for a total potential reduction of 130.0 tons per day in the year 2000, and 146.0 per day in the year 2010. The emissions reduction for the installation of wheel washers and other types of barriers are credited under paved road emissions reductions.

COST EFFECTIVENESS

The cost effectiveness of meeting the proposed requirements is estimated to be \$9,300 per ton of PM removed.

OTHER IMPACTS

The implementation of this measure will require the use of great amounts of water and may strain the Basin's water reserves. The weight of the water will add to the load on grading/excavating equipment, thereby requiring more fuel and resulting in additional ROG and CO emissions. The use of soil binders and the immediate planting of grass following construction will help control water erosion.

REFERENCES

Evans, John S., Douglas W. Cooper. 1980. "An Inventory of Particulate Emissions from Open Spaces," <u>Journal of Air Pollution Control Association</u>. December 1980.

Kwan, Ed. 1987. Orange County Construction Division. Personal communication with Steve Brunner, 1987.

CONTROL OF AMMONIA EMISSIONS FROM STATIONARY SOURCES BY PERMITS AND FEES [NH3]

SUMMARY

Source Category: Stationary NH3 Sources

Control Methods: Require Permits and Fees

Emissions: Not Determined

Control Cost: Not Determned

Other Impacts: Increased District Staffing

DESCRIPTION OF SOURCE CATEGORY

Background

Approximately 150 tons per day of ammonia is emitted to the Basin's atmosphere from many natural and man-made sources where it contributes to the formation of \mbox{PM}_{10} in the form of ammonium nitrate aerosol. General categories of ammonia emission sources and relative contributions are as follows:

| Stationary source fuel combustion | 2% |
|-----------------------------------|-----|
| Other industrial sources | 1% |
| Sewage treatment | 9% |
| Mobile source fuel combustion | 2% |
| Soil surface | 15% |
| Fertilizers | 5% |
| Domestic | 14% |
| Livestock wastes | 52% |

The requirement for control of NO_X emissions has lead to the use of ammonia as a catalyst, increasing emissions of ammonia from stationary sources. At present there is no method for obtaining data on stationary sources of ammonia.

Regulatory History

Ammonia emissions have not been subject to regulation by the District or others except for control of odors.

PROPOSED METHOD OF CONTROL

This control measure would reduce ammonia emissions by bringing ammonia sources into the District's permit and fee systems. New stationary sources of ammonia would be required to obtain permits to construct and be subject to Best Available Control Technology (BACT) requirements. Existing stationary sources would be issued permits to operate and required to comply with Best Available Retrofit Control Technology (BARCT) requirements. Fees would be charged for both permit renewal and emissions to fund the expanded workload that this requirement would impose and to provide annual emissions data for emissions inventory purposes.

EMISSIONS REDUCTION

No estimate of the impact on emissions of this control measure can be made because no BACT requirements for new stationary ammonia sources or BARCT requirements for existing stationary ammonia sources have been developed.

COST EFFECTIVENESS

No estimates of the cost effectiveness are available due to the lack of both emissions data and cost data.

OTHER IMPACTS

One major impact of this measure is an increase in District staff required to include ammonia sources in the permit system. No other adverse impacts are known or anticipated.

REFERENCES

Russell, A. and G. Cass (ed). 1987. <u>Formation and Control of Nitrogen-Containing Air Pollutants</u>. Environmental Quality Laboratory, California Institute of Technology, EQL Report 24. May 1987.

CONTROL OF EMISSIONS FROM EXEMPT EQUIPMENT [ALL POLLUTANTS]

SUMMARY

Source Category: Exempt Equipment (Under Rule 219)

Control Methods: Elimination of Exemptions

Emissions: Not Determined

Control Cost: Not Determined

Other Impacts: Additioal Workload On The District: Financial

Impact On Industry

DESCRIPTION OF SOURCE CATEGORY

Background

There are many equipment categories which are exempt from requiring a written permit. These exemptions have been granted based on the minimal level of emissions from these equipment. However, numerous small emitters, currently exempt, represent a significant additive effect on certain pollutants. Therefore, there is a need to reconsider the minimal level of emissions for exemption criteria.

Regulatory History

District Rule 219 was originally adopted to provide exemption (from requiring a written permit) for certain equipment categories which were considered to emit insignificant amounts of air pollutants.

The proposed amended Rule 219 is oriented toward reduction of emissions from equipment categories, not requiring a permit.

The proposed measure presented herein is in conjunction wilth the proposed amended Rule 219. A detailed description of the proposed measure is contained in the District's staff report on the proposed amendement (SCAQMD, 1988).

PROPOSED METHOD OF CONTROL

The proposed measure to reduce emissions from equipment categories is through eliminating certain exemptions in the current Rule 219. The proposed changes include deleting certain epuipment and/or processes from the current list of exemptions, and decreasing the threshold values for other categorial exemptions.

FMISSIONS REDUCTION

Implementation of the proposed measure will result in the reduction of emissions as a result of imposing operating conditions on new permits. The overall emission reduction would depend on the impact of the proposed measure on individual subject source categories of which no estimate is available.

COST EFFECTIVENESS

Determination of the cost effectiveness requires the consideration of all source categories being subject to the proposed measure and can not be determined due to the lack of both emissions data and cost data.

OTHER IMPACTS

Additional District workload in permit processing activities would be expected.

REFERENCES

South Coast Air Quality Management District. 1988. <u>Proposed Amended Rule 219 - Equipment Not Requiring A Written Permit Pursuant to Regulation II</u>. South Coast Air Quality Management District Staff Report. April 1988.

CONTROL OF EMISSIONS FROM SOIL DECONTAMINATION [ROG]

SUMMARY

Source Category: Soil Decontamination

Control Methods: On-Site Collection of VOC; Excavation and Removal/On-Site Treatment; Install Biological

Removal/On-Site Treatment; Install Biological Degradation Systems; Appproved Equivalent Methods

Emissions: Not Determined

Control Cost: \$36,700 Per Ton of ROG

DESCRIPTION OF SOURCE CATEGORY

Background

There are approximately 56,000 underground tanks in the South Coast Air Basin which store hazardous substances. Many of these substances are volatile and their vapor are photochemically reactive and/or toxic. The soil surrounding many of these tanks has become contaminated because of spillage and leaks from the tanks or associated piping. The contaminants in the soil can migrate and be transferred to groundwater or to the atmosphere.

State and local programs have recently been initiated to regulate the storage of hazardous substances in subsurface containers. As part of these programs, many sites are being assessed for soil contamination. In instances where significant soil contamination is found, State Department of Health has demanded the removal of VOC-laden earth to prevent underground water contamination. Soil decontamination process involves onsite aeration of the soil and purging of the organics to the atmosphere.

Regulatory History

There has been very little emphasis on prevention of exposure to direct emissions of volatile organic compounds from groundwater or VOC-

contaminated soil in the past. The proposed Rule 1166 recommends several control measures to minimize VOC emissions from soil decontamination. The proposed measure presented herein is in conjunction with the proposed Rule 1166. A detailed description of the proposed measure is contained in the District's staff report on the proposed rule (SCAQMD, 1988).

PROPOSED METHOD OF CONTROL

The choice of control measure will become effective 60 days after the date of adoption. Persons treating and handling VOC contaminated soil shall notify the District by telephone within 24 hours of discovery of the contamination. A contaminated soil treatment process shall be initiated immediately to remove the VOC contamination. These clean-up processes include: underground VOC collection systems, transporting in sealed containers to incinerator or landfill, on-site collection and destruction of VOC from excavated soil, or any equivalent contaminated soil treatment process approved by the Executive Officer.

Certain exemptions are allowed for small quantities of VOC in contaminated soil, and for sampling and emergency excavation performed under the jurisdiction of an authorized public agency upon notification of Executive Officer.

The Proposed Rule 1166 lists several possible control measures and allows the operator to select one or more of them. The Rule also has a provision to allow for the use of emerging technology with prior approval by the District. Proposed control measures are the following:

- On-site collection of VOC using air injection and vacuum wells.
- b. Excavation and removal of contaminated soil from the site in sealed containers to an appropriate dump site or to an off-site processing and control system.
- c. Excavation of the contaminated soil and treatment on-site with a portable incinerator, carbon adsorber, or equivalent processing and control equipment.
- d. Install and operate a biological degradation system approved by the Executive Officer.
- e. An equivalent means having prior approval by the Executive Officer.

EMISSIONS REDUCTION

Based on the estimated number of closures per year, and information provided by the Health Departments of the respective counties, current VOC emissions are estimated to be about 10 tons per day. Assuming that any of

the mitigation measures has an overall efficiency of 90 percent, VOC emission reduction is estimated to be about 9 tons per day.

COST EFFECTIVENESS

The cost effectiveness for soil decontamination is mostly dependent on the amount of VOC removed from the soil. For an average VOC level of 2000 ppm (by weight), the cost effectiveness is estimated to be about \$36,700 per ton of VOC reduced using extraction and incineration/catalytic oxidation. The cost effectiveness can be reduced with increased VOC levels.

OTHER IMPACTS

Implementation of this rule can significantly impact District operations for the next two years because of difficult VOC clean-up operations and hauling of VOC-contaminated soil, either to a landfill or to a treatment facility.

REFERENCES

South Coast Air Quality Managment District. 1988. <u>Proposed Rule 1166 - Volatile Organic Compound Emissions From Decontamination of Soil</u>. South Coast Air Quality Management District Staff Report. March 1988.

NEW SOURCE REVIEW [ALL POLLUTANTS]

SUMMARY

Source Category: All Permitted Sources

Require That All Emission Increases from New and Control Methods:

Modified Permitted Sources Be Offset

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | 221.0 | 259.0 | 274.0 |
| ROG Reduction | | 21.0 | 44.0 |
| NO_X Inventory NO_X Reduction | 159.0 | 122.0 15.0 | 130.0 33.0 |
| SO_X Inventory SO_X Reduction | 40.0 | 42.0 2.0 | 44.0 4.0 |
| PM Inventory | 67.0 | 82.0 | 89.0 |
| PM Reduction | | 14.0 | 29.0 |
| CO Inventory | 58.0 | 76.0 | 82.0 |
| CO Reduction | | 10.0 | 21.0 |

Control Cost: Not Determined

Other Impacts: Greater Use of Materials Which May Be Toxic; New

Sources May Not Be Able to Locate in the District,

DESCRIPTION OF SOURCE CATEGORY

Background

New equipment and modifications to existing equipment resulting in emissions increases are subject to New Source Review (NSR). These are a significant source of emissions. For instance, the cumulative increase from 1982 through 1986 for ROG from new and modified equipment was 13.6 tons per day. The intent of the District's NSR regulation was that there would be no net increases from such equipment that the increases would be entirely offset. This has not been accomplished under the present NSR.

Regulatory History

Regulation XIII is the District's current NSR regulation, and it specifically defines emissions threshold limits, which are shown in Table I. New or modified sources whose net cumulative emissions increase are above these limits must offset these emissions. This can be done by one of the following ways: (1) by reducing emissions on other equipment at the site of the new source, (e.g. equipment modification); (2) by reducing emissions at another facility owned and operated by the same company or finding an outside emissions source and securing its emission reductions; and/or (3) by obtaining emissions credits through the emissions credit banking system.

| | Table I |
|-----------------|------------------|
| Emission | Threshold Limits |
| | (lbs/day) |
| CO | 550 |
| SO ₂ | 150 |
| NO. | 100 |
| ROĜ | 75 |
| PM | 150 |
| Lead Compoi | unds 3 |

PROPOSED METHOD OF CONTROL

This measure eliminates the threshold limits and the "free market" offset system described above. Rather, all emission increases will be mitigated by allotments obtained from the New Source Siting Allowance (NSSA).

The NSSA will be administered by the District. It will be funded by emission reductions (mostly occurring as a result of shutdowns) in excess of those reductions required to reach Board established clean-air targets. Separate allocations will be established within the NSSA for different source categories: 1) Priority sources such as essential public services; 2) New sources; 3) Modified sources; 4) Intermittent sources. The allotments will be distributed to the sources on a quarterly basis.

Sources unable to obtain access to NSSA allotments may still obtain offsets through innovative emission reduction controls. These reductions can occur at some stationary source other than the source they are required at.

EMISSIONS REDUCTION

Implementation of this control measure will result in the mitigation of all emissions increases from new and modified sources. The emissions inventory and reduction are contained in the summary table.

COST EFFECTIVENESS

The cost effectiveness of implementing proposed control measure is uncertain at this time and requires further analysis.

OTHER IMPACTS

Implementation of this measure will result in greater use of materials which do not lead to emissions of criteria air contaminants but which may not be as safe, or may be toxic.

New sources may not be able to locate in the District, nor may existing sources be able to expand operations.

LOW EMISSION METHODS AND MATERIALS FOR BUILDING CONSTRUCTION [ROG. PM]

SUMMARY

Source Category: Various Building Construction

Control Methods: Prohibit High Emitting Building Construction

Methods and Materials

Emissions: Not Determined

Control Cost: Not Determined

Other Impacts: Possible Increase In Toxic Emissions

DESCRIPTION OF SOURCE CATEGORY

Background

The construction of residential, commercial, and industrial buildings results in emissions from both the methods and materials used. Construction materials which emit ROG include: sealers, primers and paints for wood, stucco, plaster, and wallboard; wood stains; concrete curing compounds; adhesives for flooring and ceiling products; structural adhesives; caulking compounds; plastic pipe cleaners and solvents; underground waterproofing materials; asphalt roof coatings and cements; and asphalt paving materials. Construction methods which emit PM include: sawing wood and metals; grinding concrete and metals; sanding wood, primed surfaces, and plasters; spray painting; pneumatic concrete placement; pneumatic debris removal; and sweeping.

Regulatory History

The building methods and materials that are allowed for use are specified in building codes enacted by local ordinances. Building code requirements are intended "to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within (local jurisdictions) and certain equipment..." (ICBO, 1979). The Federal Housing Administration

(FHA) has established Minimum Property Standards "intended to provide a sound technical basis for FHA mortgage insurance by providing minimum standards which will assure well planned, safe, and soundly constructed homes" (FHA, 1966). The purpose of building codes and FHA standards is to provide for safety and durability of inhabited structures; the air pollution potential of the materials used in construction of these structures is not a concern.

PROPOSED METHOD OF CONTROL

There are usually several methods and materials capable of meeting the needs of building owners while meeting the minimum code requirements and standards; some of these methods and materials result in lower emissions than others. There is also the potential for developing new methods and materials which could result in still lower emissions; however, there is no incentive to do so at this time. In order to reduce emissions from this source, an evaluation of the emissions from various building methods and materials would be required. This information could then be used to (1) identify those methods and materials which could be prohibited without sacrificing building safety or durability and (2) identify areas for research in new methods and materials. Eliminating high emitting methods and materials will stimulate research by others once a market for such methods and materials has been established. Examples of methods and materials that would result in lower emissions are: (1) preprimed and sanded wood moulding and trim products, (2) preprimed wallboard, and (3) vacuuming in lieu of pneumatic debris removal.

EMISSIONS REDUCTION

There are no specific estimates of the PM and ROG emissions from building methods and materials or the potential for emissions reductions. The ROG emissions from building materials is either included in a more general category (e.g., architectural coatings) or has been considered too small to inventory separately (e.g., plastic pipe solvents). The PM emissions are mostly dependent on the specific contruction methods.

COST EFFECTIVENESS

No cost effectiveness estimate is available.

OTHER IMPACTS

Some building materials contain toxic compounds. Low ROG emission building materials may emit toxic compounds.

REFERENCES

International Conference of Building Officials (ICBO), 1979. "Uniform Building Code". 1979 Edition.

Federal Housing Administration (FHA). 1966. "Minimum Property Standards for One and Two Living Units". U.S. Department of Housing and Urban Development, Federal Housing Administration. FHA No. 300. November 1966.

PHASE-OUT STATIONARY SOURCE FUEL OIL AND SOLID FOSSIL FUEL USE [NO_X, PM, SO_X]

<u>SUMMARY</u>

Source Category: Stationary Sources

Control Methods: Phasing Out the Use of Fuel Oil and Solid Fossil

Fuels

| [missions: | | | |
|--|------------------|------------------------|-----------------|
| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>ear 2010</u> |
| NO_X Inventory NO_X Reduction | 22.0 | 27.6 Not Determined | 30.2 f |
| PM Inventory PM Reduction | 1.7 | 2.6 Not Determined | 2.8 d |
| SO _X Inventory SO _X Reduction | 10.8 | 15.9 Not Determine | 16.0 d |

Control Cost: \$18,900 to \$32,300 Per Ton of NO_X

Other Impacts: Safety Concerns in Handling, Storage and

Transportation of Methanol; Expedite Clean Fuels Program; Public Utilities Commission Regulations

DESCRIPTION OF SOURCE CATEGORY

Background

There are two major types of fuel oils: distillate and residual. Distillate oils are used mainly in domestic and small commercial applications. Residual oils, on the other hand, are used mainly in utility, industrial, and large commercial applications. Residual oils are heavier, more viscous and less volatile than distillate oils and must be heated for ease of handling and to facilitate proper atomization. Because residual oils are produced from the residue left over after the lighter fractions (e.g., produced from the residue left oils) have been removed from the crude oil, they contain significant quantities of ash, nitrogen, and sulfur (USEPA, 1973).

Solid fossil fuels are coal or any form of solid fuels derived from fossil materials. Their use is very limited in the Basin.

Fuel oil, mainly residual, is used in limited quantities in power plants, refineries and industrial processes. Power plants and some industrial users consume fuel oil on a stand-by basis, primarily in the event of a natural gas curtailment or increased power demand.

The primary pollutants resulting from burning fuel oils and solid fossil fuels are ${\rm NO}_{\rm X}$, PM, and ${\rm SO}_{\rm X}$ which can impose significant impacts on the air quality in the Basin.

Regulatory History

District Rules 431.2 and 431.3 regulate the sulfur content of liquid and fossil fuels in the Basin. Proposed Rules 1146, 1109, 1134, and 1135, currently under rulemaking process, are oriented toward minimizing NO_χ emissions from power generating boilers and tubines, refinery heaters and boilers, and industrial and commercial boilers, steam generators, and process heaters.

Proposed Rule 1146 sets a NO_X emission limit of 40 ppm for industrial, commercial and institutional boilers, steam generators, and process heaters regardless of fuel type (liquid or gas). Proposed Rules 1109, 1134, 1135 require a limit of 0.03 pounds of NO_X per million BTU per hour of heat input for refinery boilers and heaters, utility boilers and gas tubines. The adoption of the proposed rules will virtually eliminate the use of fuel oil as the primary fuel. Therefore, this control measure provides for the contingency that liquid and solid fuels might still be used if (1) the proposed rules are not adopted, and (2) new processes using these fuels are introduced to the Basin.

The District Board on its May 1988 meeting approved a recommendation to phase out the use of fuel oils and solid fossil fuels in stationary sources in the Basin.

PROPOSED METHOD OF CONTROL

The proposed measure to control emissions of NO_X , PM and SO_X associated with the combustion of fuel oils and solid fossil fuels is to phase out the use of all fuel oil (distillate and residual) and solid fossil fuels used by stationary sources.

The proposed measure focuses on eliminating the use of fuel oil and solid fossil fuels under all conditions, including, but not limited to, natural gas curtailment, increases in power demand (in the case of power plants), and emergencies.

The options available include natural gas, methanol, and other alternative fuels. Based on demonstration tests performed on utility boilers, methanol

can offer a viable alternative for controlling emissions. Other alternative fuels which can burn at least as clean as methanol may also be utilized.

EMISSIONS REDUCTION

In 1985, oil and soild fossil fueled stationary sources emitted 22.0 tons per day of NO_{X} , 10.8 tons per day of SO_{X} , and 1.7 tons per day of PM. The potential reductions can not be determined and will vary depending on types of equipment, operating conditions and types of fuel switching to. In general, if natural gas is selected, over 50 percent reduction in No_{X} is expected; if methanol is used, approximately 60 to 90 percent reduction is expected. These reductions do not consider the effect of the proposed rules described above.

COST EFFECTIVENESS

The cost effectiveness is calculated based on the following assumptions: (1) switching to methanol; (2) annual reduction of about 2000 tons of NO_X , 242 tons of SO_X , and 170 tons of PM; (3) methanol price of \$0.35 to \$0.45 per gallon; and (4) distillate oil price of \$0.55 per gallon and \$0.45 per gallon for residual fuel oil. The cost effectiveness is estimated to be approximately \$18,900 to \$32,300 per ton of NO_X reduced. It should be noted that the control expenditures esimated for NO_X reduction can simultaneously reduce SO_X and PM.

OTHER IMPACTS

The use of methanol as an alternative fuel may raise safety issues concerning the methanol handling, storage and transportation because of its flammability and toxicity. Additional controls would be needed (i.e. phase I and phase II vapor recovery systems) to ensure safe storage and transfer of methanol with minimal vapor loss. Also, due to the corrosive nature of methanol, storage tanks and their associated pipes would be required to be made of non-corrosive material. Further study may be required for refinery heaters to determine the effectiveness of methanol in reducing emissions under different operating conditions.

The measure will also expedite the implementation of the District's Clean Fuels Program in both the stationary and transportation sectors. By phasing out fuel oil and fossil fuel use, it would be possible to provide for more competitive pricing of clean fuels relative to gasoline. Also, the transportation cost for methanol will be reduced due to increased demand for clean fuels (SCAQMD, 1987).

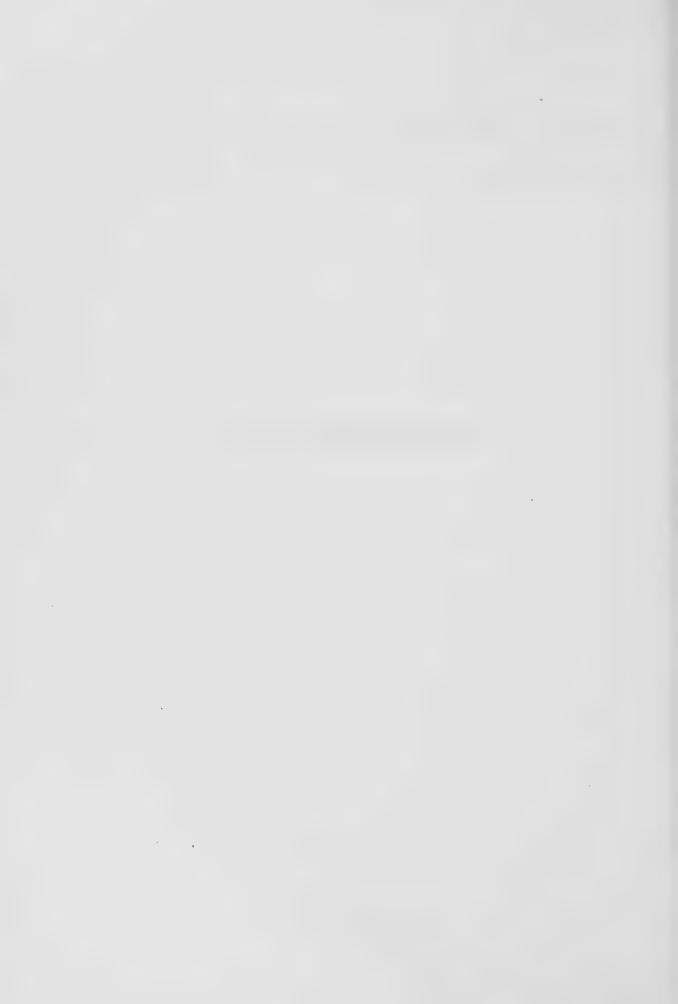
In order to discourage the use of fuel oils as substitutes for natural gas in the Basin, the District may request the Public Utilities Commission to consider adopting regulations and explore pricing policies.

REFERENCES

South Coast Air Quality Management District. 1987. Recommendation to Adopt a Five-Year Clean Fuels Program. Adopted in January 1988.

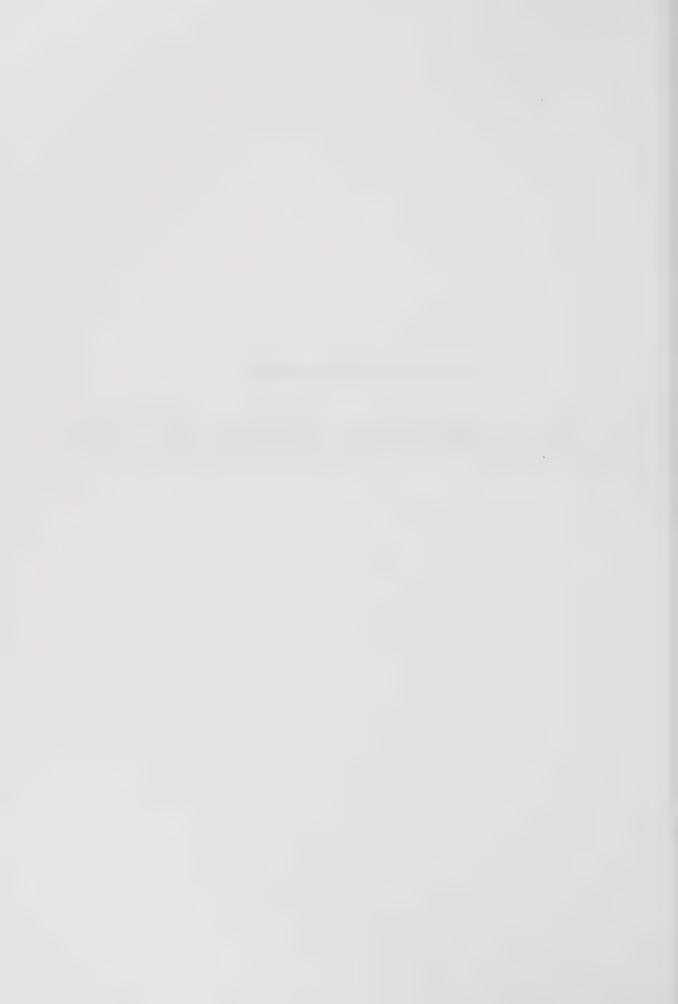
U.S. Environmental Protection Agency. 1973. <u>Air Pollution Engineering Manual</u>. May 1973.





TRANSPORTATION SOURCES

This section contains transportation sources contributing to the emissions in the Basin. Tables I-2G through I-2I represent proposed control measures aimed at reducing emissions from these sources, followed by detailed description of control measures.



G- MOTOR VEHICLES

The control measures proposed for reducing emissions from motor vehicles are listed in Table I-2G. The concepts of control measures for each of the source categories are described in detail in the following section.

TABLE I-2G TIER I CONTROL MEASURESMOTOR VEHICLES

| AQMP | CONTROL No. | TITLE |
|------|----------------|--|
| G-1 | | Urban Bus System Electrification, [All Pollutants] |
| G-2 | | Clean Fuel Retrofit of Transit Buses, [NO _X , SO _X , PM] |
| G-3 | | Use of Radial Tires on Light Duty Motor Vehicles, [PM] |
| G-4 | | Clean Fuels in New Fleet Vehicles, [All Pollutants] |

URBAN BUS SYSTEM ELECTRIFICATION [ALL POLLUTANTS]

SUMMARY

Source Category: Heavy Duty Vehicle

Control Methods: Electrification of Transit Busses Using

Conventional Technology

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------------|------------------|------------------|------------------|
| ROG Inventory ROG Reduction | 1.64 | (Not determin | ed) |
| NOx Inventory NOx Reduction | 9.48 | (Not determin | ed) |
| PM Inventory PM Reduction | (Not determined | 1) | |
| CO Inventory CO Reduction | 4.84 | (Not determin | ed) |

Control Cost: Depends Upon Level of Implementation, May Represent

Cost Saving.

DESCRIPTION OF SOURCE CATEGORY

Background

Electrification of transit bus operations is a common practice in major urban areas throughout the world. In the United States San Francisco and Seattle both operate extensive electric transit bus systems. Use of a trolley and overhead wire distribution systems is an established technology for electrification of transit busses.

Los Angeles once operated a limited system of trolley busses in the central business district (CBD). This system was removed in 1963 along with all

remaining streetcar service in the CBD. These busses were subsequently sold to Mexico City where they continue to operate today.

San Francisco is undertaking an extensive electrification program over 70% of the bus hours operated are expected to be electrified by 1992. The State of California and the Federal government have provided funding for bus electrification programs. Operating experience in San Francisco and Seattle shows that it is feasible to operate pollution free electrified transit busses successfully in an urban area.

Regulatory History

Caltrans, SCAG, and the District are each participating in various electric vehicle technology development and demonstration projects. Electrification of transit bus operations by the use of conventional technology is a measure that could be undertaken as part of this ongoing effort.

PROPOSED METHOD OF CONTROL

The proposed method of control is to install overhead trolley wires for power transmission to transit busses operating along major fixed routes. Services that run continuously along major arterials at intervals of 15 minutes or less would be candidates for conversion from diesel operation directly to electric operation.

Transit operators would acquire and operate the electric busses along these routes. Routes that run infrequently, or on very circuitous routes would not be electrified but would convert to clean fuels.

EMISSIONS REDUCTION

Efficiency of this control measure would be almost 100% on routes converted to electric bus operation. Replacement of heavy diesel busses by electric busses would reduce ROG, CO, NOX, and PM10 levels from this source to virtually zero.

COST EFFECTIVENESS

The cost of this control measure would depend upon the number of route miles of bus operations that would be electrified. Experiences in San Francicso, Seattle, and Vancouver, British Columbia indicate that operation of electrified transit busses is more cost effective than diesel bus operations on heavily used lines.

The longer operating life of electric vehicles, the lower maintenance costs and higher reliability may provide significant cost savings for the transit operating agencies. Better riding characteristics, cleanliness, and other

line service characteristics of electrified transit busses may attract new patronage, raising fare box recovery and ease subsidy burdens.

OTHER IMPACTS

High capital cost for installation of the power distribution system may require new innovations in capitalization. The possibility of having the electric utilities in the region undertaking the installation of the distribution system should be explored.

Additional electric generating capacity may be necessary for transit bus electrification. This may depend upon other technological changes affecting the demand for electricity.

REFERENCES

San Francisco Municipal Railway. 1983. <u>A Preliminary Plan For Trolley Coach Expansion</u>. Planning Division. 1983.

Southern California Rapid Transit District. 1985. <u>Technical Report on the Cost of Converting Line 204 to trolley Coach Operation</u>. 1985.

National Academy of Sciences. 1983. <u>The Trolley Bus:Where It Is and Where It's Going, Special Report 200.</u> Transportation Research Board. National Research Council. Urban Mass Transportation Administration, U.S. Department of Transportation. 1983.

Leicester, Glen. 1988. B.C. Transit, Vancouver, British Columbia. Personal Communications with Mr. Robert Huddy, March 1988.

Lawrence, Llew. 1988. Edmonton Transit, Edmonton, Alberta. Personal Communication with Robert Huddy, March 1988.

CLEAN FUEL RETROFIT OF TRANSIT BUSSES [NO., SO., PM]

<u>SUMMARY</u>

Source Category: Heavy Duty Vehicle

Control Methods: Retrofit of Existing of Transit Busses With

Clean Fuels Technology.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 1990</u> * | <u>Year 2000</u> * |
|--------------------------------|------------------|--------------------|--------------------|
| ROG Inventory ROG Reduction | 1.5 | 1.7 1.8* | 2.2 |
| NOx Inventory NOx Reduction | 8.5 | 9.9 4.9 | 12.7 0 |
| PM Inventory PM Reduction | 1.3 | 1.5 | 1.9 |
| SOx Inventory SOx Reduction | 0.7 | 0.8 0.8 | 1.0 |

^{*} See Emissions Reduction Section

Control Cost: Depends Upon Level of Implementation, May Represent

a Substantial Short Term Fuel Cost Increase

Other Impacts: Operational and Budgetary Impacts on Transit

Service Levels

DESCRIPTION OF SOURCE CATEGORY

Background

Emission levels for diesel transit busses are very high compared to other heavy-duty diesel vehicles. This is because of the operating characteristics of transit bus service. Low speed operation on heavy density lines is the typical operating condition for transit busses. This

type of service results in continuous stop-and-go driving which contributes to higher emission levels.

Transit busses have a typical life expectancy of 12 years and some transit busses may operate up to 16 years. The average age of the transit bus fleet operating in the basin is approximately 8 years. It is expected that a significant portion of those busses presently operating may still be operating after new transit bus emission standards become effective in 1991, but would be phased out by 2000.

The use of diesel engines in transit busses contributes to the high level of PM and NOx emissions. Substitution of alternative clean fuels for diesel fuel in new transit busses is being done on a limited scale. Southern California Rapid Transit District has ordered 30 methanol powered busses for service in 1989.

Regulatory History

The Health and Safety code was amended in 1987 to give the District authority to require fleets to use alternative clean fuels in the Basin.

The PM standard for urban bus engines will be 0.1 g/Bhp-hr beginning with the 1991 model year. In order to meet this standard without the use of particulate traps, ARB has proposed that new urban transit busses purchased after 1991 be methanol powered.

PROPOSED METHOD OF CONTROL

Require Retrofit of Existing Transit Bus Fleet to Clean Fuels Technology

The District could require conversion of all or part of the existing transit bus fleet to alternate clean fuels technology. Diesel operated busses would be required to replace the existing fuel system with a clean fuel burning system. Alternate clean fuels could include methanol, compressed natural gas (CNG), propane, liquefied natural gas (LNG), or some other clean fuel product.

Retrofit of the fuel system could be done as part of normal life-cycle maintenance or rehabilitation of the bus. Typically bus engines are replaced three times during the normal life cycle of the vehicle. Retrofit standards could be applied to the bus fleet based upon expected remaining vehicle life.

EMISSIONS REDUCTION

The control efficiency would depend upon the alternate fuel technology utilized. It would also depend upon the level of implementation of the control technology over time.

Air Resources Board (ARB) estimates that methanol conversion of new busses after 1991 will virtually eliminate PM emissions from this source. ARB has also estimated that a fifty percent reduction of NOx would occur from this substitution. The same results would be expected from retrofitting the existing bus fleet. ROG levels increase from methanol substitution due to greater mass and increased evaporative emissions.

Benefits due to clean fuel retrofit no longer exist after the existing bus fleet is replaced (8-16 years). Due to the turnover of the existing transit bus fleet, it is unlikely that significant numbers of retrofitted busses would be operating by 2000. Therefore,

COST EFFECTIVENESS

Orange County Transit District has estimated the cost to be approximately \$40,000 per vehicle for methanol conversion. In addition the lower BTU rating of methanol may require more fueling for the same level of bus transit service. Alternate clean fuels technologies may have different cost components than methanol. These costs have yet to be determined.

The cost of retrofitting diesel busses may be lower if such retrofitting is done in conjunction with normal bus rehabilitation, when the bus is between 5 and 8 years old. Research to determine the cost per ton for retrofitting the existing bus fleet would have to be calculated for this measure. The method of conversion and the level of conversion would affect this calculation.

OTHER IMPACTS

Budget constraints severely limit the ability of the transit agencies to provide service. Additional budgetary burdens due to retrofit of existing fleets to clean fuels technology may restrict the transit agencies ability to provide increasing service levels called for under the Transit Improvement measure.

REFERENCES

Air Resources Board. 1988. <u>Motor Vehicle Control Measures for Inclusion in SCAQMD's Planning and Modeling Efforts (Draft)</u>. 1988.

Scholl, Steve. 1988. Orange County Transit District. Personal communication with Robert Huddy, 1988.

USE OF RADIAL TIRE ON LIGHT-DUTY MOTOR VEHICLES [PM]

<u>SUMMARY</u>

Source Category: Light Duty Passenger Vehicles

Control Methods: Ban Bias-ply Tires on Light-Duty Passenger Vehicles

| Emissions: (Tons/Day) | <u>Year 1985</u> | Year 2000 | <u>Year 2010</u> |
|--------------------------|------------------|-----------|------------------|
| PM Inventory | 45.0 | 55.0 | 64.0 |
| PM Reduction | | 3.1 | 3.7 |

Control Cost: Savings

Other Impacts: Fewer Tires May Need To Be Disposed Of Because Of

The Longer Lifetime Of Radial Tires.

DESCRIPTION OF SOURCE CATEGORY

Background

Nationwide, approximately 88 percent of tires on domestic passenger cars in 1987 were radial tires and the remaining 12 percent were bias-ply tires. Although the initial cost of radial tires is slightly more than that of bias-ply tires. Radial tires last approximately 50 percent longer.

As tires wear they produce particulate matters that are emitted into the air. Requiring vehicles to use radial tires instead of bias-ply tires would reduce the particulate matters emitted into the air.

Recent evidence suggests that market forces may be acting to encourage people to switch to radial tires. For over five years, radial tires have come as original equipment on new cars. The proliferation of discount tire stores have helped decrease the disparity between the price of radial and non-radial tires. Furthermore, on a per mile basis, radial tires are cheaper than bias-ply. On a nationwide basis, 93 percent of tires shipped are expected to be radials.

The vehicle fleet in Southern California, however, tends to be older than the nation-wide average. Older vehicles which came equipped with bias-ply tires as well as newer cars seeking to use bias-ply tires as replacements are the primary focus of this control measure.

PROPOSED METHOD OF CONTROL

Radial tires would be required for all replacement tire sales for light-duty passenger vehicle tires. A ban would be then phased in over a two to three year period.

EMISSIONS REDUCTION

Tire wear from light-duty passenger and truck vehicles accounted for approximately 45.0 tons per day of PM in 1985. Projected emissions for the years 2000 and 2010 are expected to be 55.0 and 64.0 tons per day, respectively. By requiring only radial tires to be used on light duty passenger vehicles 5.7 percent reduction is expected in the amount of particulate matter emitted by passenger vehicle tires in the years 2000 and 2010, which would be 3.1 and 3.7 tons per day.

COST EFFECTIVENESS

In 1986, the cost of a typical radial tire was approximately \$54. The comparable cost for bias-ply tires was between \$35 to \$38. Given that a radial tire lasts 50 percent longer than non-radial tires, radial tires are cheaper over the life-time of the tire.

OTHER IMPACTS

A potential secondary effect from requiring radial tires on all light-duty passenger vehicles is a decrease in the overall number of tires that require disposal because of the longer lifetime of radial tires.

CLEAN FUELS IN NEW FLEET VEHICLES [ALL POLLUTANTS]

SUMMARY

Source Category: Fleet Vehicles

Control Methods: Require Fleet Vehicle Operators to Purchase Only

Vehicles Capable of Operating on Alternative Fuels

Emissions: Not Determined

Control Cost: Not Determined

Other Impacts: Unknown Long-Term Public Health Effect of Exposure

to Methanol and it's Exhaust Product, Formaldehyde;

Reduced Dependency on Imported Petroleum Fuel

DESCRIPTION OF SOURCE CATEGORY

Background

A survey of the 15 public transit fleets and 4,500 non-transit fleets operating in the South Coast Air Basin was conducted by Urban Innovations Group (UIG) under contract with the South Coast Air Quality Management District. Based on 100 percent response from the public transit fleets and about 10 percent from non-transit fleets, several fleet characteristics were identified. Fleet vehicles constitute under 6 percent of the total vehicle population in the District, and account for a similar share of miles driven. The average fleet vehicle is driven a little over 10,000 miles annually. Fleets are classified as public transit and non-transit, with only 1 percent of fleet vehicles belonging to the former class. Such public transit vehicles as buses, however, are driven over 30,000 miles annually. Only 40 percent of the surveyed non-transit vehicles operated exclusively in the basin. New vehicles planned for purchase over a three year period (1985 to 1988) indicated a growth of 25 percent. About 60 percent of the fleets had less than 50 vehicles and operated only 6 percent of the fleet vehicle population. Approximately 5 percent (24) of the fleets surveyed had 500 or more vehicles and operated about 70 percent of the fleet vehicle population. Of these 24 fleets, 15 were publicly owned/leased.

Of the 88,000 non-transit vehicles included in the aggregate of all the responding fleets, over 50 percent of the vehicles are cars and light trucks; about 25 percent are medium and heavy trucks; approximately 14 percent are premium heavy-duty trucks; and about 3 percent are buses (not including public transit fleets).

More than 90 percent of the cars and light, medium, and heavy trucks are powered by gasoline engines; while more than 65 percent of the premium heavy-duty trucks are powered by diesel engines. About 12 percent of all non-transit fleet vehicles consumed 34 million gallons of diesel fuel in 1984, while the remainder consumed 64 million gallons of gasoline. This is 6.5 percent and 1.5 percent, respectively, of the total district consumption of 526 million gallons of diesel fuel and 4.4 trillion gallons of gasoline.

About 73 percent of the non-transit fleets have centralized, on-site fueling facilities. About 27 percent of the fleets do all of their fueling at centralized facilities, while another 27 percent do none of their fueling at centralized facilities. Of the remainder, most fleets do more than half of their fueling at centralized facilities.

The average life of transit vehicles is 11 years with 3 engine rebuilds. Non-transit vehicles average about 8.6 years with 2 engine rebuilds or overhauls. The Southern California Rapid Transit District operates about 72 percent of the 4,444 transit buses.

Regulatory History

Recent California legislation (Senate Bill 151) has authorized the South Coast Air Quality Management District to adopt regulations that will require operators of public and commercial fleets consisting of 15 or more vehicles under a single owner or lessee operating primarily in the South Coast Air Basin when replacing vehicles, to purchase and operate vehicles which employ clean fuel technology. Clean fuel technology includes methanol, compressed natural gas, electricity, propane, and fuel cells, and can be used to power fleet vehicles while producing much lower levels of air pollutants compared to conventional petroleum based fuels such as diesel or gasoline.

PROPOSED METHOD OF CONTROL

The proposed control measure would require fleet operators of public and commercial vehicle fleets, consisting of 15 or more vehicles under a single owner or lessee and operating substantially in the South Coast District, when adding to or replacing vehicles in an existing fleet or purchasing vehicles to form a new fleet, to purchase vehicles capable of operating on an alternative fuel. The most likely alternative for most fleet operators on gasoline or methanol.

The compliance schedule when the measure is adopted will be synchronized with the availability of production vehicles, which is anticipated to begin in 1992. The goal is to have 15 to 30 percent of fleet vehicles operating on clean fuels by the year 2000.

Methanol

Engines operating on methanol and variable combinations of gasoline and methanol have been under development since 1980. Automotive engine sizes of 1.8, 5.0, and 6.6 liters (from Ford) and 2.8 liters (from General Motors) are currently in field demonstration test programs, as are heavyduty, 200-horsepower diesel bus engines. Heavy-duty truck demonstration programs are due to commence in September, 1988. Three of the 6 truck engine manufacturers are committed to such programs.

Electricity

The current technology that would provide the most significant emission reductions on a per-vehicle basis is that of electric vehicles (EV's) operating on batteries. Technology is progressing to develop batteries that provide greater range and higher speeds for electric vehicles, to extend their life expectancy, and to enhance their recycling potential. Batteries currently under development include nickel/iron, nickel/cadmium, lithium/metal-sulfide, and sodium/sulfur. Presently, electric vehicles are using heavier DC motors. Lightweight AC motors are currently being tested for use in EVs for increased range, power, and acceleration.

General Motors is currently testing demonstration vans and will begin production of a limited-range (60 miles per battery charge) van with a top speed of 55 mph for the 1989 model year. Their range is expected to increase to 120 miles as nickel/iron batteries are available in the next few years. Chrysler is scheduled to introduce a half-ton mini-van in 1990 with a driving range of 150 miles and a top speed of 70 mph. It will accelerate from 0-30 in 7 seconds.

Compressed Natural Gas

The gas industry hopes to market approximately 1 million natural gas vehicles (NGV's) in the United States by the year 2010. Based on the current use of natural gas in the 30,000 NGV's in this country, the American Gas Association (AGA) estimates that 1 million cars would use less than 100 billion cubic feet of natural gas per year, which equivocates to about one-half of the annual production of U.S. natural gas. Burning natural gas directly eliminates the large loss of energy involved in converting it to methanol. The conversion efficiency of natural gas is about 85 percent, and about 60 percent for methanol.

The U.S. already has a 1.5 million mile underground pipeline system that is used to transport natural gas to nearly 300 compressed natural gas (CNG) refueling stations. This pipeline transportation system would allow natural gas to be delivered to vehicles safely and efficiently without

encountering the risks inherent in transporting liquid fuels over surface roads. Additional pipeline, as well as a compressor and high-pressure storage equipment, is needed for the installation of a refueling station.

According to a recent AGA survey of fleet managers whose fleets are at least partially composed of natural gas vehicles (NGV's), NGV injury rates per vehicle mile were 84 percent less than the national average for all U.S. registered vehicles. In addition, no deaths occurred in the cumulative 434.1 million miles driven by the sample fleet.

Natural gas is lighter than air and disperses readily. It is ignitable only in a very narrow range of gas-to-air ratios. A mixture of about 5 to 15 percent natural gas is most efficient. Its flammability is about 1200 to 1300 $^{\rm O}$ F, much higher than that of gasoline.

Others

There are a number of other alternative fuels and power plants which are applicable to vehicles. The Department of Energy estimates almost 4 million liquid petroleum gas (LPG) vehicles used commercially worldwide. LPG is marketed as propane or butane. It differs from natural gas in two ways: (1) LPG is heavier than air, and (2) it has a higher heating value. Propane has the highest heating value, 3200 Btu/ft³, while butane is 2400 Btu/ft³. LPG works well at 150 psi, while CNG or LPG results in extended engine life and less maintenance than the use of gasoline.

EMISSIONS REDUCTION

Due to the unavailability of complete emissions data for all fleet vehicles operating within the South Coast Air Basin, emission reductions for all pollutants on a per ton basis were unable to be determined. However, emission reductions available from the implementation of the alternative fuels measure have been estimated for each fuel type.

Based on California Air Resources Board (CARB) emission standards and the resultant emission factors, the average per-vehicle baseline ROG emissions (including I/M credits) for 1990+ vehicles will be:

| Vehicle Category | ROG Emissions | | |
|--------------------------|-----------------------------|--|--|
| Passenger Cars (LDA) | (Pounds/1,000 miles) 116 | | |
| Light-Duty Trucks (LDT) | 123 | | |
| Medium-Duty Trucks (MDT) | 138 | | |
| Heavy-Duty Trucks (HDT) | 453 | | |

It is widely recognized that, except for electric vehicles, many variables affect vehicle emissions. In addition to the type of fuel, factors affecting emissions include engine size and type, age, tuning, emission control devices, temperature, speed, and load. In addition, tuning to minimize one pollutant may increase the emission of another. Late model vehicles with fuel injectors, computer controlled engines, and the latest in emission controls have greatly reduced emissions from gasoline fuel. It can be anticipated that incorporation of computer controlled carburetion engines using alternative clean fuels along with effective emission controls will offer even more improved emission reductions. With all of these variables, quantifying the emissions of various fuels becomes complex.

Methanol

Methanol has the potential to reduce ozone formation because unburned fuel in the exhaust has a lower photochemical reactivity than the hydrocarbons in the exhaust of gasoline vehicles. The use of methanol to replace gasoline reduces ROG emissions by 50 percent.

Electricity

The use of electric vehicles to replace gasoline vehicles reduces emissions of CO and ROG by 100 percent and of NO $_{\rm X}$ by 75 to 100 percent (depending on whether power is generated within or outside the Basin). Therefore, the percent of emission reduction from electric vehicles is fully equal to the percent of gasoline vehicles they replace.

Compressed Natural Gas (CNG)

Emission tests on two new natural gas-fueled buses in an EPA-approved test laboratory showed the engines produced about half of the diesel particulates allowed in the 1984 standard; 25 percent of the CO; 12 percent of the NO $_{\rm X}$; and 24 percent of the hydrocarbons. According to A.G.A.'s report to a U.S. Senate Subcommittee, the conversion of gasoline- or diesel-fueled vehicles to natural gas can reduce CO emissions by up to 99 percent, reduce No $_{\rm X}$ emissions by up to 65 percent, and reduce reactive hydrocarbon emissions by up to 85 percent. Actual emissions depend upon the design, tuning, and age of the vehicle, and the condition of the condition of the controls and the conversion kit.

EPA estimates that NGV's could reduce both reactive hydrocarbon emissions and carbon monoxide emissions by 50 to 90 percent. They also found the NO $_{\rm X}$ emissions from NGV's to vary from a 20 percent decrease to an increase of 80 percent. An assessment by the Aerospace Corporation for the Department of Energy reported CARB test results on emissions from 14 gasoline light-duty vehicles converted to natural gas. The results showed average duty vehicles converted to natural gas. The results showed average emission reductions of 29 percent for reactive hydrocarbons, 92 percent for carbon monoxide, and 50 percent for NO $_{\rm X}$.

COST EFFECTIVENESS

Methanol

Assuming a break-even price in fuel, a \$100 to \$300 vehicle cost increase, a \$300 maintenance cost increase over a 100,000 mile vehicle life, and a 116 pound ROG reduction per 1,000 miles, the cost effectiveness is \$3.45 to \$6.03 per pound (or \$6,900 to \$12,100 per ton) of ROG reduced.

Electricity

Assuming a 40 to 80 percent greater mileage life over conventional vans (CV's), the Electric Vehicle Development Corporation estimated the lifecycle costs for EV's to be 29 to 35 percent greater than conventional vans. For vans traveling 8,000 to 11,000 miles per year, these life-cycle costs amounted to 37 to 39 cents per mile for EV's and 27 to 30 cents per mile for CV's. Break-even gasoline prices for the use of EV's would be \$1.79 to \$2.27. Break-even EV lifetimes would be 143,000 to 165,000 miles of fleet service (considered realistic for EV's). These costs assume \$14,500 for the vehicle plus \$4,750 every four years for a battery.

As emerging battery technology eliminates battery watering as a maintenance factor, the EV costs decrease to 34 to 36 cents per mile. Factors expected to bring maintenance costs of EV's below that of CV's are (1) emerging maintenance-free battery technology and (2) the inherent reliability and longevity of electric propulsion systems.

Compressed Natural Gas

On a total operating cost-per-mile basis, which includes all levelized conversion, compressor station and fuel costs, natural gas is the only alternative fuel capable of out-performing gasoline. For a 100 vehicle fleet comprised of 90 sedans and 10 light trucks, the national fleet average of 25,000 miles per year per vehicle, natural gas vehicles enjoy an 11 percent savings in operating costs relative to gasoline (5.6 cents per mile versus 6.3 cents per mile). Total operating costs for these NGV's are equal to gasoline vehicles at an annual mileage rate of approximately 16,500 per vehicle, with NGV's being more economical than gasoline vehicles at any mileage greater than 16,500.

A payback analysis indicates that retrofitting gasoline vehicles to run on natural gas, in many instances, is economically beneficial. The payback periods were analyzed to range from 2.5 to 6.1. years. The paybacks are shortest for vehicles with low fuel mileage and high fuel usage. For example, a fleet of 30 transit buses exhibits payback periods ranging from 2.5 to 4.5 years.

OTHER IMPACTS

Adverse impacts associated with the use of alternative fuels include unknown public health effects of exposure to methanol and it's exhaust product, formaldehyde. Increased utilization of alternative fuels can aid in reducing the U.S dependency on imported petroleum fuel.

REFERENCES

South Coast Air Quality Management District Staff Report: "Proposed Rule 1601; Fleet Vehicle Conversion to Clean Fuels". May 1988.



H- TRANSPORTATION SYSTEM AND LAND USE

Transportation system and land use sources contributing to the emissions in the Basin are listed in Table I-2H. Detailed description of proposed control measures for each of these source categories are discussed in the following section.

TABLE I-2H TIER I CONTROL MEASURESTRANSPORTATION SYSTEM AND LAND USE

| AQMP CON No. | TITLE |
|-----------------|--|
| H-1 | Disincentives for Idling at Drive-Through Facilities, [ROG, ${\sf NO}_\chi, {\sf CO}]$ |
| H-2 | Limitations on Vehicle Registration, [All Pollutants] |

DISINCENTIVES FOR IDLING AT DRIVE-THROUGH FACILITIES [ROG, NO_{x} , CO]

SUMMARY

Source Category: Light Duty Passenger

Control Methods: Restrictions on Design or Banning New

Drive-Through Facilities

Fmissions:

Year 2010 Year 2000 Year 1985 (Tons/Day) 2149 1881 CO Inventory 3040 (Not determined) CO Reduction

Control Cost: Varies By Type of Design Required

Other Impacts: Reduced Traffic Congestion; Perhaps Some Secondary

Safety Effects From Improved Access to Main Facility

DESCRIPTION OF SOURCE CATEGORY

Background

Drive-through facilities are a convenience that allows people to transact business without leaving their automobiles. These facilities are common in both banks and fast-food restaurants. Several local jurisdictions limit the location or number of drive-through facilities or restrict their design to reduce idling time and congestion through zoning, land use and permit ordinances. Proposed drive-through facilities are also reviewed as a part of some city and county planning processes to determine their impact on traffic congestion and local environmental and aesthetic impacts.

Drive-through facilities can cause extensive vehicle idling as vehicles wait for service. Vehicle emissions can be reduced by limiting the idling time of vehicles waiting in line for service.

Regulatory History

In the County of Sacramento, drive-through facilities are regulated through use permits. By imposing design criteria, the County helps reduce congestion and time spent idling in the drive-through. In addition, several air quality districts in Northern California have recognized the use of restrictions on drive-through facilities in preventing localized carbon monoxide build-ups.

PROPOSED METHOD OF CONTROL

Control strategies which limit vehicle idling time include restrictions on design, location, or construction of drive-through facilities. Ideally, the wait in line would be minimized (decreasing idling emissions) while encouraging use of the drive-through facility to avoid stopping and starting the engine again. A design such as double drive-up windows in which money is taken at one window and food or some other product is provided at another window is an example.

EMISSIONS REDUCTION

Carbon monoxide (CO) would be the primary pollutant reduced by this control strategy. It is estimated that idling vehicles at drive-through facilities accounted for approximately 3040 tons per day of CO emissions in 1985. Projected emissions for the years 2000 and 2010 are expected to be 1881 and 2149 tons per day, respectively. If the vehicle is turned off and restarted, there is a substantial increase in ROG and NOx emissions than if the car had remained idling.

COST EFFECTIVENESS

The cost of the control measure depends on the type of restriction considered. If design and construction restrictions are imposed on new facilities, it is easier to incorporate the new design features than altering the design of existing facilities. For existing facilities, the ease and cost of redesign and new construction can differ substantially.

OTHER IMPACTS

Localized traffic congestion stemming from vehicle entering and exiting the drive-through facility may be affected. Secondary safety effects may also be attributed to design alterations.

LIMITATIONS ON VEHICLE REGISTRATION [ALL POLLUTANTS]

SUMMARY

Source Category: Light Duty Passenger

Control Methods: Limitations On the Number of Vehicle Registered

In the Basin '

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 336.8 | 117.9 | 117.8 |
| ROG Reduction | | 5.9 | 5.9 |
| NOx Inventory | 274.0 | 158. 0 | 160.1 |
| NOx Reduction | | 7.9 | 8.0 |
| CO Inventory | 2593.5 | 1369.4 | 1395.6 |
| CO Reduction | | 68.5 | 69.8 |

Control Cost: Not Determined

Other Impacts: Possible Impact on the Amount of Revenue Received

From Registration Fees at the State and Local Level

DESCRIPTION OF SOURCE CATEGORY

Background

As the Basin's population increases, the number of vehicles operating within the Basin is also expected to grow. In 1985, approximately 5.7 million gasoline and diesel-fueled light-duty passenger vehicles were in use. In the year 2000, 6.5 million such vehicles are projected to be in operation. By the year 2010, over 7 million gasoline and diesel-powered light-duty passenger vehicles are anticipated to be operating.

Regulatory History

The State of California's Department of Motor Vehicles requires vehicles operating within the state to be registered and to pay an annual registration fee. Counties can also collect a fee, up to \$1, to install and improve call boxes. At the same time that the vehicle is registered, vehicle owners must pay a license fee equivalent to 2 percent of the vehicle's assessed value.

PROPOSED METHOD OF CONTROL

The number of gasoline and diesel-powered light-duty passenger vehicles registered to operate legally within the Basin could be restricted in several ways. Limitations could be placed on the number of vehicles registered per driver or per household. A cap could be placed on the number of vehicles registered within the Basin, with vehicles registered on a first-come, first-served basis or allocated by lot. This latter approach could be refined by taking the availability of public transportation into account, and allocating vehicle registrations by geographic sub-region. Furthermore, operation of clean-fueled vehicles could be encouraged by exempting electric vehicles rom the restriction and placing different limitations on clean-fueled vehicles.

Alternatively, registration fees within the Basin could be set high enough so as to discourage vehicle ownership and operation within the Basin. Alteration of the fee structure would, however, require significant detailed economic analysis to ensure setting fees at the appropriate level. Operation of clean-fueled vehicles could be encouraged by requiring lower registration fees for these types of vehicles.

The efficiency of the control measure depends on several factors. These include the adequacy of enforcement, the emissions level of the vehicles in the vehicle fleet (i.e., less benefit is derived from cleaner vehicles), the level at which the registration limit is set, and the method of implementation chosen.

Enforcement efforts would need to be enhanced to ensure that vehicles were not registered out-of-state or outside the Basin in an attempt to avoid the restrictions. Additional enforcement and stiffer fines would also be necessary to make sure that unregistered vehicles did not proliferate.

EMISSIONS REDUCTION

If 5 percent of the vehicles anticipated to operate in the Basin in 2000 could be eliminated by placing a cap on vehicle registrations, it is expected that the emissions from 325,000 vehicles could be eliminated by the year 2000. The appropriate level of registration limitations will depend on factors listed previously.

Emissions and potential reductions are estimated as follow:

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 336.8 | 117.9 | 117.8 |
| ROG Reduction | | 5.9 | 5.9 |
| NOx Inventory | 274.0 | 158.0 | 160.1 |
| NOx Reduction | | 7.9 | 8.0 |
| CO Inventory | 2593.5 | 1369.4 | 1395.6 |
| CO Reduction | | 68.5 | 69.8 |

Emission reductions will depend on the number and type of vehicles restricted. The reductions noted above are based on a 5 percent reduction in the passenger vehicle fleet, assuming no increase in use of remaining vehicles.

COST EFFECTIVENESS

Stringent enforcement would be required to ensure compliance with the control measure. Significant costs would be incurred to enforce the limitations on vehicle registration. The cost effectiveness for this control measure is uncertain at this time and requires further analysis.

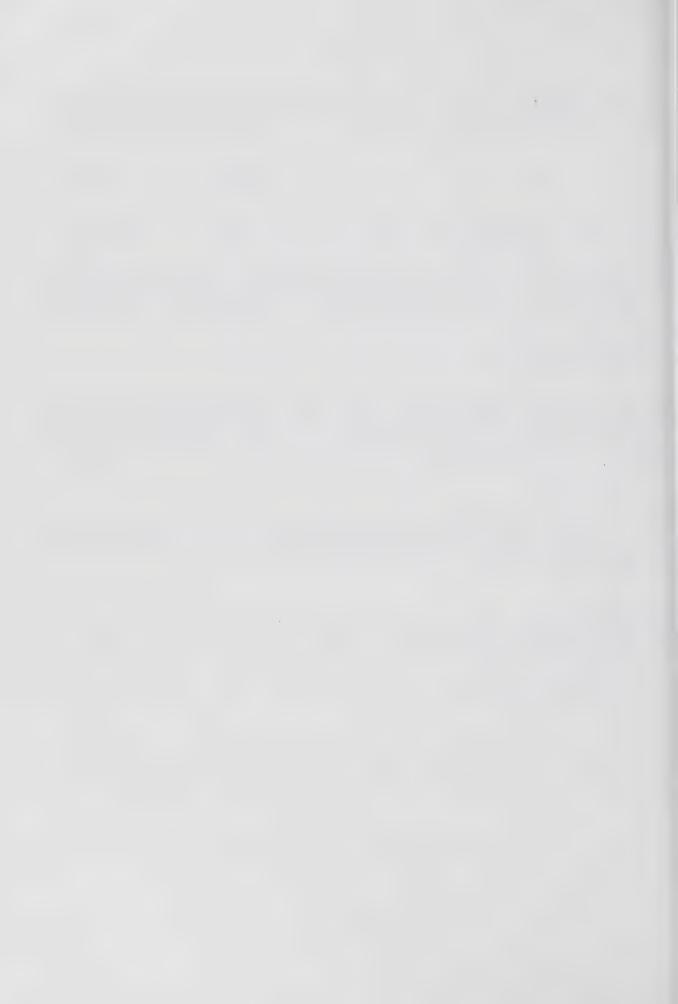
OTHER IMPACTS

Limitations on the number of vehicles registered in the Basin could have a substantial impact on the revenue received by the state and local jurisdictions through registration fees.

REFERENCES

California Department of Transportation. 1986. <u>Travel and Related Factors</u> in <u>California</u>. 1986.

Los Angeles County Transportation Commission. 1987. On the Road to the Year 2000. August 1987.



I- OFF ROAD VEHICLES

Table I-2I contains the listing of the control measures proposed to reduce emissions from off road vehicles sources. Detailed description of the control measures for each of these sources are described in the following section.

TABLE I-2I TIER I CONTROL MEASURESOFF ROAD VEHICLES

| . TITLE |
|--|
| Control of Emissions from Ship Berthing Facilities, [NO _X] |
| Control of Emissions from Jet Aircraft, [ROG, CO,NO _X] |
| Control of Emissions from Marine Vessel Tanks, [ROG] |
| Control of Emissions from Marine Diesel Operations, $[NO_X]$ |
| Limit on Sulfur Content of Marine Fuel Oils, [SO _X] |
| Control of Emissions from Pleasure Boat, [ROG, NO _X] |
| Control of Emissions from Switching Locomotives, [All Pollutants] |
| |

CONTROL OF EMISSIONS FROM SHIP BERTHING FACILITIES [NO.]

SUMMARY

Source category: Ship Berthing Facilities

Control Method: Use of Shore-Side Electrical Power In Place Of

Ship Engine While At Berth (Cold Ironing)

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| NO _x Inventory | 15.3 | 17.8 | 18.6 |
| NO _x Reduction | | 4.5 | 4.7 |

Control Cost: \$25,300 Per Ton Of NO,

Other Impacts: Additional Electrical Facilities Including

Substations And Transformers Will Be Required;

Safety Concerns

DESCRIPTION OF SOURCE CATEGORY

Background

As marine vessels arrive in ports and dock to load and unload cargo, their engines are typically kept running to provide power for the ship's utilities, such as light, heat, pumps, refrigeration, ventillation and cargo winches. Oil is used as the primary fuel to power both steamships and motorships (diesel powered). Fuel combustion in the boilers of steamships and the main and the auxiliary diesel engines of motorships generate NO_{χ} emissions along with minor amounts of ROG, SO_X , CO and PM from ships at berth (Pearson, 1969).

Regulatory History

Ship Berthing facilities are currently not regulated by the District. The proposed Rule 1165 is directed toward reduction of ${\rm NO}_{\rm X}$ emissions from ships at berth. The proposed rule requires marine vessels to shut down their engines and/or boilers while at berth and use shore-side electrical power for the ship's various electrical needs (cold ironing). The proposed control measure presented herein is in conjunction with the subject proposed Rule 1165 for this source category. Detailed description of the proposed measure is contained in the District's feasibility study

report on the proposed rule (SCAQMD, 1987).

PROPOSED METHOD OF CONTROL

The proposed method to reduce NO_X emissions from ship berthing facilities is to require marine vessels to shut down their power sources (i.e. boilers and engines) while at berth and connect ship's electrical systems to shoreside power supplied by public utilities. At present, there are not permanent facilities at the ports of Long Beach and Los Angeles for providing electrical services from shore to ships. To provide electricity, facilities will require additional electrical distribution equipment including low voltage substations at or near each berth.

Cold ironing is presently used in the U.S. Navy facilities at Terminal Island, at the Muscat Cement Terminal in the port of Los Angeles, and in the port of Tacoma, Washington.

Motorships which comprise about 77.5 percent of all ships entering Los Angeles and Long Beach harbors lend themselves more readily to cold ironing. However, there are some tankers that may require steam or inerting gas for heating and ship-loading/unloading operations. Normally, inerting gas is supplied by the exhaust from onboard fired boilers and diesel engines. Steam-powered ships including cargo, passenger ships and tankers comprise the remaining 22.5 percent of all ships (based on 1983 inventory). These ships may be very difficult to adapt to cold iron, since many steam powered ships have essential systems depending on steam production for their safe operation.

Alternative No_X emission controls will be explored for steamships, oil tankers, and ships that come in for bunkering only which can not be readily adapted to cold ironong (SCAQMD, 1987).

EMISSIONS REDUCTION

In 1985, ship berthing facilities contributed to 15.3 tons per day of NO_X emissions in the Basin. The projected NO_X emissions for the years 2000 and 2010 are 17.8 and 18.6 tons per day, respectively. Since this control measure is only applicable to a certain portion of motorships, the emissions reductions from this source category are estimated to be 4.5 and 4.7 tons per day of NO_X in the years 2000 and 2010. They are based on the assumption that the required power will be supplied from out-of-Basin.

COST EFFECTIVNESS

In order to comply with the requirements of this measure, it was assumed that 130 substations will be needed in the ports of Los Angeles and Long Beach. It was also assumed that 1500 ships have to be retrofitted during the first year and 500 ships per year in the subsequent years. The cost effectiveness of this control measure, therefore, is \$25,300 per ton of NO_{X} reduced.

OTHER IMPACTS

Implementation of the propsed control measure will require additional installations of electrical substations and associated portable panels to cold iron ship berthing facilities, including wiring, transformers and circuit breakers. The proposed measure may also raise safety issues in regard to the handling of electrical equipment used for cold ironing.

REFERENCES

Pearson, James R. 1969. <u>Ships As Sources Of Emissions</u>. Pugent Sound Air Pollution Control Agency, Seattle, Washington. 1969.

South Coast Air Quality Management District. 1987. Proposed Rule 1165 - Emissions Of Oxides Of Nitrogen From Ships At Berth (Cold Ironing). South Coast Air Quality Management District Feasibility Study. November 1987.

CONTROL OF EMISSIONS FROM JET AIRCRAFT [ROG,CO,NO_Y]

Summary

Source Category: General Aviation and Commercial Aircraft

Control Methods: Engine Modification and Engine Redesign;

Methanol Demonstration Program.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | 13.3 | 19.3 | 22.5 |
| ROG Reduction | | 9.6 | 11.3 |
| CO Inventory | 23.7 | 33.1 | 38.1 |
| CO Reduction | | 16.5 | 19.1 |
| NO_X Inventory NO_X Reduction | 11.4 | 14.8 7.4 | 16.7 8.3 |

Control Costs: \$560 to \$810 per ton of ROG

\$245 to \$320 Per Ton of CO

Other Impacts: None.

DESCRIPTION OF SOURCE CATEGORY

Background

Section 231 of the Clean Air Act as amended directs the Administrator of Environmental Protection Agency (EPA) to issue emission standards for aircraft engines. In 1973, the EPA proposed emission regulations for several classes of aircraft and aircraft engines (FR, 1973). The affected pollutants were evaporative and exhaust hydrocarbon, smoke, CO, and NO_{X} emissions.

The Federal Aviation Administration (FAA) has operated a program to develop certification procedures for the use of methanol in aircraft since June, 1985, and anticipates joint efforts with the EPA regarding emission standards (Chartier, 1987). The methanol-to-jet-fuel requirement ratio for

aircraft is only 1.1 to 1 (Cooper, 1987). Since methanol is potentially acceptable as an aircraft fuel, the FAA has assigned it a specfic color code, bright yellow.

Regulatory History

For the purposes of emission regulations, all aircraft engines have been divided into eight classes. Three tiers of standards were promulgated: retrofit standards for in-use engines, standards for newly manufactured engines (built after the regulation's effective date), and standards for newly certified engines (designed and certified after the effective date).

On March 24, 1978, EPA published a Notice of Proposed Rulemaking to make major changes to the existing aircraft rules (FR, 1978). With respect to engine retrofit standards for gaseous emissions, it was proposed to extend the applicability of retrofit standards to all turbojet/turbofan aircraft engines of 53 kilonewtons (kN) or greater thrust and to all JT8D engines. This proposal was withdrawn in 1982 (FR, 1982).

PROPOSED METHOD OF CONTROL

For newly manufactured engines, the EPA's originally proposed HC and CO standards should be retained for engines of 90 kN and greater thrust, but for engines between 27 and 90 kN a continuous transition of the standards with thrust is proposed. The implementation dates for the HC and CO standards are proposed to take effect four years after adoption. Finally, this proposal would apply current smoke and fuel venting emission standards to all aircraft gas turbine engines of the JT8D model family by 1991.

This control measure proposes adopting the following standards proposed by EPA in 1978:

- o HC, CO, and NO_{X} emission standards for all aircraft gas-turbine engines used only for general aviation applications.
- o HC, CO, and NO_{χ} emission standards for aircraft gas-turbine engines of rated thrust less than 26.7 kilonewtons.
- o HC, CO, and NO_{X} emission standards for newly certified aircraft gas-turbine engines in all rated thrust categories.
- o All retrofit standards originally proposed by EPA in 1978.

Additionally, this control measure proposes the adoption of a rule to demonsrate, among other criteria, a 40 to 60 percent emissions reduction on take-off and similar reductions for idling.

The use of mixed methanol-jet fuel requirement is also potentially acceptable proposed measure and EPA should be encouraged to join their efforts with the FAA to demonstrate and evaluate methanol applications.

Emission reductions associated with this control measure is uncertain at this time and requires further analysis.

EMISSIONS REDUCTION

The EPA has determined that the technology developed for compliance with New Manufactured Engine HC and CO standards is readily adaptable to in-use engines within a four year period (FR, 1978). The primary engine class affected by these new standards would be aircraft engines in the 12,000 to 29,000 pound rate thrust category. The emissions reduction of the proposed regulation would result primarily from the retrofitting of emission controls on in-use aircraft engines.

These control methods are estimated to have the following emissions reductions (Chartier, 1987):

| <u>Emissions</u> | Reductions by Engine <u>Modification</u> | Reductions by use of <u>Methanol</u> |
|------------------|--|--|
| ROG | 50% | 80-90% |
| CO | 50% | 65% |
| NO _× | 50% | 50-65% |

Applying the engine-modifications control factors to the inventory, it is estimated that this measure would reduce future emissions as follows:

| Emissions (Tons/Day) | <u>Year 1985</u> | Year 2000 | <u>Year 2010</u> |
|---------------------------|------------------|-----------|------------------|
| ROG Inventory | 13.3 | 19.3 | 22.5 |
| ROG Reduction | | 9.6 | 11.3 |
| CO Inventory | 23.7 | 33.1 | 38.1 |
| CO Reduction | | 16.5 | 19.1 |
| NO _x Inventory | 11.4 | 14.8 | 16.7 |
| NO _x Reduction | | 7.4 | 8.3 |

COST EFFECTIVENESS

On the basis of the information available from aircraft industry sources, the average costs of these proposed standards are estimated to be:

| Category | Cost Per Engine | Increase In price |
|----------------------------|--------------------|----------------------|
| Newly Manufactured Engines | \$159,000 | 10% |
| In-Use Engines | \$ 64,000 | 7% |

These costs are upper limit estimates. The actual costs may be lower. This translates into a cost effectiveness of \$560 to \$810 per ton of ROG and \$245 to \$320 per ton of CO reduced. This excludes any probable maintenance penalty.

OTHER IMPACTS

No adverse impact is expected from this control measure.

REFERENCES

Chartier, Jean. 1987. Federal Aviation Administration, Western Aircraft Certification Office, Propulsion Section, ANM-174W; Hawthorne, CA. Personal communication with Larry Irwin, December 1987.

Cooper, Astronaut Gordon. 1987. XL Inc., Los Angeles. (FAA contractor). Personal communication with Larry Irwin, December 1987.

Federal Register, 38:19090, July 17, 1973.

Federal Register, 43:12615, March 24, 1978.

Federal Register, 47:58464, December 30, 1982.

Jordan, Bruce C., 1977. An Assessment of the Potential Air Quality Impact of General Aviation Emissions. Environmental Protection Agency, June 1977.

Naugle, D.F. and Fox, D.L., 1981. "Aircraft and Air Pollution", Environmental Science and Technology April 1981.

Seitchek, Glenn 1985. <u>Aircraft Engine Emissions Estimator</u>. U.S. Air Force, Engineering and Services Center, Tyndall Air Force Base. November, 1985.

- U.S. Environmental Protection Agency. 1977. <u>Aircraft Emissions at Selected Airports 1972-1985</u>. EPA AC 77-01 January 1977.
- U.S. Environmental Protection Agency. 1976 <u>Aircraft Technology Assessment--</u>
 <u>Status of the Gas Turbine Program</u>. December 1976.

CONTROL OF EMISSIONS FROM MARINE VESSEL TANKS [ROG]

SUMMARY

Source Category: Marine Vessel Operations.

Control Methods: Add-on Control Devices; Operational Requirements

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|--------------------------|------------------|------------------|------------------|
| ROG Inventory | 3.7 | 4.0 | 4.1 |
| ROG Reduction | | 3.8 | 3.9 |

Control Cost: \$400 to \$4,400 Per Ton of ROG for Housekeeping Control

\$0 to \$934,000 Per Ton of ROG for Ballasting

Operations

Other Impacts: Shift in Housekeeping Jobs from Contractors to Crews

in Some Cases.

DESCRIPTION OF SOURCE CATEGORY

Background

Meteorological conditions along the coast of the Basin are such that offshore emissions are carried ashore most of the time, particularly during the summer smog season. This pollutant transport has been demonstrated by macrometerological analyses, analyses of diurnal wind regimes and tracer studies.

As petroleum tankers and barges load and unload petroleum and other organic liquids, reactive organic gases (ROG) are emitted. These emissions occur from several different petroleum tank vessel operations including: (1) loading-the loading of a tanker or barge with petroleum or organic chemicals; (2) lightering-the transfer of organic liquid cargo from one marine tank vessel to another; (3) ballasting-the loading of ballast water into cargo tanks to obtain proper propeller, rudder and hull immersion; and (4) housekeeping-altering the composition of gases contained within cargo tanks by tank washing, gas freeing, or purging. Reactive organic vapors

that have evaporated from organic liquid cargoes during or just prior to these operations are expelled from the vessel's cargo tanks, either by the introduction of liquids, by flushing with inert gas or air, or by vapor expansion caused by atmospheric temperature and pressure variation (breathing).

Breathing emissions comprised about 12 percent of the ROG emissions from marine vessels in 1979 (CARB, 1984). This amounted to about 92 tons for that year in the District ports.

With the exception of emissions resulting from the incomplete combustion of fuel and small quantities of emissions from bunkering, "dry cargo" vessels do not emit organic vapors.

Regulatory History

The control methods proposed herein are based on the findings of the Marine Vessel Emissions Task Force (CARB, 1984) and on ARB Technical Assessment Documents (TADs) (CARB, 1987). The Task Force, made up of representatives from both industry and local and state regulatory agencies, was established to provide an appraisal of methods and costs of controlling hydrocarbon and sulfur oxides emissions from marine vessels. The findings of the Task Force were given to the ARB staff for the development of a Suggested Control Measure (SCM) for the statewide Technical Review Group. After reviewing the available data pertinent to the control of ballasting and drydock preparation (housekeeping) emissions, the ARB staff prepared the TADs in lieu of an SCM. The TADs contain the emissions impacts and costs for a broad spectrum of control options for these operations, and recommend that local districts select the appropriate option(s) for their areas. The Task Force did not discuss controls for breathing emissions.

U.S. Coast Guard regulations (CFR, 1986) already require tankers, that ballast into crude oil washed tanks, to control ROG emissions from that operation, whenever they are in areas that do not meet the federal ozone standard. These regulations also require tankers to have inert gas systems with associated vapor controls, or dedicated ballast tankage, either of which is sufficient equipment to control the emissions from ballasting operations. However, several classes of tankers are exempt from these regulations and can emit ROG while ballasting into cargo tanks.

The U.S. Coast Guard is currently sponsoring a study by the National Academy of Sciences on the feasibility of safely controlling the vapor emissions from tanker loading operations (Nishimura, 1987). When the results of the study are available in December, 1987, the Coast Guard may develop further safety regulations for marine tank vessel operations. Many coastal states, such as New Jersey and Texas, are awaiting the results before promulgating local requirements. However, Rhode Island and Oregon presently apply marine vessel regulations to new sources in conjunction with current Coast Guard requirements.

The Bay Area AQMD recently suspended workshops for the development of regulations pending the National Academy of Science study (Nishimura, 1987). The Santa Barbara APCD already regulates "organic liquid cargo tank vessel loading", requiring 95 percent control efficiency under Rule 327 (Shavritz, 1987). For vessel operations at new berthing facilities the South Coast District requires inert gas systems (for unloading) and segregated ballast tanks as BACT.

PROPOSED METHOD OF CONTROL

Each of the different petroleum tank vessel operations which result in ROG emissions involves the displacement of vapors from a tank into the atmosphere by an incoming liquid or gas. Methods to control such vapors have been known and used successfully in other applications for several years. They are vapor balance, refrigeration, lean oil absorption, carbon adsorption, incineration, and combinations thereof. They control ROG emissions from filling storage tanks, tank trucks, railroad tank cars, and gasoline service station tanks, and can also be applied to reduce emissions from marine tank vessel operations.

Loading Operations

Emissions from loading operations should be controlled aboard the vessels or at dockside. A vapor balance and recovery system controlling 98 percent of loading emissions has recently begun operation at the Tosco refinery in the San Francisco Bay Area, while a similar system is in testing by Gaviota Trading Company (a partnership of Chevron and Texaco) in Santa Barbara (Shavritz, 1987). Exxon is currently equipping 15 ships with lean oil absorption and carbon adsorption controls in Santa Barbara and San Francisco. Texaco and Arco are taking similar steps to reduce emissions (Nishimura, 1987). Refrigeration, incineration and combinations thereof are also suggested by the Task Force as appropriate for loading operations (CARB, 1984).

Lightering Operations

Emissions from lightering operations should require controls aboard the lighter vessel, or the use of the vapor balance process. The latter requires a simple vapor line connection to return vapors from the lighter-vessel tanks being loaded back to the parent-vessel tanks being unloaded. Those vapors would then be contained within the cargo tanks of the parent vessel until it departed the coastal waters of the Basin.

Exxon currently has one lighter vessel, the Exxon Houston, equipped with vapor balance equipment, with a second, the Exxon Galveston, was due for retrofit by the end of 1987 (Nishimura, 1987). The cargo compartments are manifolded for both loading and vapor collection.

Ballasting Operations

Controls should be required for emissions from ballasting operations. This could be done by directing the vapors to shipboard control devices (e.g., refrigeration, absorption, adsorption, or incineration). Alternative controls, which are already required by the Coast Guard on all new tanker vessels over 20,000 dwt (deadweight tons), are: (1) common vent manifolds (such as that in the inert gas system), and/or (2) requiring operations that will accomplish one of the following methods.

- O Compression ballasting--This involves taking on water with all of the tanker's cargo vapor spaces interconnected and with all vents to the atmosphere closed. With the initial tank pressure sufficiently low, ballast water can be taken on up to the pressure set point of the tank pressure/vacuum valves. The compresssed vapors are retained until the vessel departs coastal waters
- o <u>Dedicated ballasting</u>--The use of certain tanks to carry only ballast water.
- o <u>Internal vapor balance ballasting</u>--This uses the common vent manifold to transfer vapors from cargo tanks being ballasted into cargo tanks simultaneously being unloaded.
- o <u>Ballast tank selection</u>--This is ballasting into tanks which had previously contained low volatility cargo when multiple cargo grades are carried.
- o <u>Light loading</u>--This involves using less than capacity so that certain tanks are reserved for ballasting. This is essentially dedicated ballasting on a per voyage basis for tankers that cannot employ any of the above methods.

In addition to one of the above methods to control ballasting emissions, the following method should be required during severe weather conditions.

o <u>Dedicated ballast reservation</u>--This involves reserving cargo tanks for ballast when severe weather conditions require ballast beyond the capacity of dedicated ballast tanks. Emissions would be eliminated by using one of the other control methods concurrent with the unloading of other cargo tanks, leaving the dedicated ballast tanks to be filled later.

Housekeeping Operations

Controls should be required for emissions from housekeeping operations. Emissions could be controlled by directing the vapors to control devices (e.g., refrigeration, absorption, adsorption, or incineration) on board the vessel, or by delaying these operations until the vessel is outside of a vessel, or by delaying these operations would not have an impact on the specified zone to ensure that the emissions would not have an impact on the Basin's air quality.

FMISSIONS REDUCTION

Marine vessel operations accounted for approximately 3.7 tons of ROG per day in 1985. Emission estimates for 2000 and 2010 are 4.0 and 4.1 tons per day, respectively.

It is important to note that these emission estimates reflect average daily ROG emissions. Since emissions from vessel operations are not continuous in nature, but rather are event related, the emissions on any particular day could be significantly higher, ranging from 4 to 40 tons per event. (CARB, 1987)

Implementation of this measure provides about 95 percent emissions reduction, approximately 3.8 tons per day in 2000, and to 3.9 tons per day in 2010.

These inventories and reductions do not include the vapors already controlled as a result of Coast Guard regulations mentioned above. In 1979 cargo tankers, which are since then required to have dedicated ballasting, accounted for 92 percent of all tanker ballasting emissions (CARB, 1987). Yet in 1987, 30 to 50 percent of all tanker ballasting is still done in cargo tanks (Levine, 1987). Therefore, Coast Guard regulations are considered to be only 50 to 70 percent effective at this time.

COST EFFECTIVENESS

The cost effectiveness depends on the methods used, the volatility of the cargo, the loading rate, the annual throughput, the size of the tanker vessel, the control options, the amount of time required to commute between regulated and unregulated boundaries, and the prior tank washing conditions.

Ballasting Controls

Ballasting control costs would affect only Coast Guard-exempt vessels (product tankers delivered before July 1, 1987, and having a capacity between 20,000 and 40,000 deadweight tons; and all tankers of less than 20,000 dwt). Only about 5 percent of the petroleum product entering District ports is "product" (Buck, 1987). However, if any of these vessels employed refrigeration, absorption, adsorption, or incineration equipment on shipboard, no additional costs to control ballasting emissions would be necessary. For these vessels the cost of reducing emissions from both loading and ballasting operations would be lower as the same equipment is used for both.

Coast-Guard-exempt vessels not employing these shipboard controls on ballast emissions and using one of the following ballast methods only once per year into hot water washed gasoline tanks would incur the following costs. The vast majority of vessels unloading in District ports do so more than 10 times annually, and many on a biweekly basis.

| BALLAST METHOD | CONTROL EFFICIENCY (%) | COST EFFECTIVENESS \$/ton ROG reduced for vessels of | |
|---|------------------------------|--|------------|
| | | 20,000 dwt | 40,000 dwt |
| Ballast Tank Selection* | 50-99 | 0 | 0 |
| Internal Vapor Balance * & Compression Ballasting | * 100 | 64,000 | 48,000 |
| Light Loading** | 100 | 352,000 | 228,000 |
| Dedicated Ballast & Ballast Reservation** | 100 | 934,000 | 606,000 |

^{*} This method only applies to tanker vessels carrying low volatility cargo.

Housekeeping Controls

Vessels employing refrigeration, absorption, adsorption, or incineration equipment on shipboard would incur no additional costs to control housekeeping emissions. For these vessels the cost of reducing emissions from loading, ballasting, and housekeeping operations would be lower as the same equipment is used for all three.

Vessels not employing these shipboard controls, and opting to normally conduct housekeeping operations outside the California Coastal Region (for 100% control efficiency), would incur the following costs. Possible exemptions are tankers carrying only low-volatility cargo.

| Vessel Size | Wash Condition | Cost Effectiveness \$/ton ROG reduced |
|----------------|---|--|
| 30,000 dwt | Crude Oil Washed Unwashed | 1,300 3,800 |
| 190,000 dwt | Crude Oil Washed Unwashed | 400 1,200 |
| 20,000 dwt | Hot Water Washed Unwashed | 1,800 4,400 |
| 40,000 dwt | Hot Water Washed Unwashed | 1,800 4,200 |
| | Size 30,000 dwt 190,000 dwt 20,000 dwt | Size Condition 30,000 dwt Crude Oil Washed Unwashed 190,000 dwt Crude Oil Washed Unwashed 20,000 dwt Hot Water Washed Unwashed 40,000 dwt Hot Water Washed |

^{**} Costs for these categories require further analysis and are under review by the ARB.

** Example costs here are for a tanker that would carry 50% gasoline and 50% low-volatility products.

OTHER IMPACTS

The District has primary legal authority to regulate marine vessel emissions which affect onshore air quality. That authority is subject to limitation only if federal law specifically preempts the District, or if state or local regulations would result in a direct unconstitutional burden on interstate or international commerce.

Implementation of this control measure would need to be jointly administered by the District, U.S. Coast Guard and the Los Angeles and Long Beach Port Authorities. Some of these costs can be allocated to other benefits, such as water quality and safety.

REFERENCES

Buck B. 1987. Personal communication with Larry Irwin, 1987.

California Air Resources Board. 1984. Report to the California Legislature on Air Pollutant Emissions From Marine Vessels, Sacramento, CA.

California Air Resources Board. 1987. <u>A Technical Document for Reducing Photochemically Reactive Organic Compound Emissions From Marine Tank Vessel Ballasting Operations</u>, Sacramento, CA.

California Air Resources Board. 1987. <u>A Technical Document for Reducing Photochemically Reactive Organic Compound Emissions From Marine Tank Vessel Housekeeping Operations Conducted in Preparation for Drydock Entry, Sacramento, CA.</u>

Code of Federal Regulations. 1986. Title 33 Sections 157.132 and 157.166; and Title 46, Section 32.53.

Levine, B. 1987. Personal communication with Larry Irwin, August 1987.

Nishimura, B. 1987. Personal communication with Larry Irwin, August 1987.

Shavritz, B. 1987. Personal communication with Larry Irwin, August 1987.

CONTROL OF EMISSIONS FROM MARINE DIESEL OPERATIONS $[NO_{x}]$

Source Category: Marine Diesel Engines.

Control Methods: Reduce Cruising Speeds; Prohibit By-Passing

Ships From Entering District Coastal Waters

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| NO_X Inventory NO_X Reduction | 32.7 | 37.9 6.4 | 39.6 6.7 |

Control Costs: \$5,400 Per Ton of NO,

Other Impacts: Energy Conservation; Enforcement Requires

Coordination with Coast Guard; Minor Increase

in Cruising Time.

DESCRIPTION OF SOURCE CATEGORY

Background

Motorships (cargo, tanker, military) and tugboats (pulling barges) use diesel engines to provide power for maneuvering, cruising, and berthing operations (which for tankers includes loading, unloading, ballasting, and housekeeping). The exhaust from these engines contains NO_X emissions. Motorships comprised about 78 percent of all the commercial ships that harbored in District waters in 1983, and generated about 95 percent of their NO_{X} emissions (Halberg, 1984). The remainder was from steamships.

The NO_X emissions from diesel motorships are largely from foreign dry-cargo motorships. These vessels generated about 85 percent of the NO_{χ} emissions and comprised 72 percent of the commercial ships arriving in 1983. Cruising operations by the motorships generated about 29 percent of the 1983 marine vessel NO_X emissions. In addition, an unknown number of commercial ships only cruise through District waters, passing through without harboring.

There are approximately 5000 movements per year, of diesel-driven maritime vessels in the 10,000/15,000 shaft-HP class into the District harbors. There are about 120 movements per year of tankers in the 25,000 shaft-HP class. Most of these large vessels have automatic variable-beginning-type injection timing devices. These devices provide variable degrees of retardation at lower engine speeds and will permit additional retardation to provide a 20-25 percent average reduction in NO $_{\rm Y}$ at lower engine RPMs.

Regulatory History

Measure N13 in the 1979 Plan was replaced by Measure L6 of the 1982 AQMP Revision (SCAQMD, 1982). This control measure reintroduces Measure L6, which proposed the reduction of NO $_{\rm X}$ emissions from Marine diesel engines. It was reintroduced in the District's report "Hearing on Controls of Oxides of Nitrogen (NO $_{\rm X}$)", February 1986; and in AQMP Working Paper No. 4 published in November 1986. No action has been taken to implement the measure.

The District's Proposed Rule 1165 (electrification) will prohibit motorships from operating diesel engines while at berth, thereby eliminating about 52 percent of the NO_X emitted from commercial vessels (Halberg, 1984). If adopted, this rule will probably not be in effect before 1992.

PROPOSED METHODS OF CONTROL

There are two circumstances under which emissions from cruising operations should be controlled: (1) when ships enter and leave port, or anchor to unload to a lighter vessel, and (2) when ships cruise through District Waters without docking or lightering.

Ships Harboring

The NO_X emissions of marine diesel engines should be controlled by requiring a throttle setting reduced by 20 percent while cruising within the District coastal waters. Reducing the cruising speed by 20 percent reduces fuel consumption in higher proportion. It is estimated that it would reduce NO_X emissions by about 36 percent for that operation.

This option would not require modifications of equipment. This is an important consideration since many vessels are infrequent visitors. Assuming an existing average speed of 20 knots and a worst-case 60-mile distance from port, a 20 percent reduction in speed will cause a maximal delay of 45 minutes. This delay is less than 1 percent of the time required for an average 2000 mile journey.

Ships Passing Through

Ships merely cruising through District Coastal Waters should be required to stay outside of its boundary, if possible. This would help minimize emissions from ships cruising between ports outside the District.

EMISSIONS REDUCTION

Marine vessel operations which could be affected by this measure accounted for approximately 32.7 of NO_{X} per day in 1985. Emission estimates for 2000 and 2010 are 37.9 and 39.6 tons per day, respectively.

Implementation of this control measure should provide a 17 percent emissions reduction, approximately 6.5 tons per day in 2000, and 6.7 tons per day in 2010.

Ships that pass through District Coastal Waters, but do not enter the LA/LB Harbors, are not included in this emissions inventory as no such records are kept. Prohibiting by-passing ships from entering District Coastal Waters would provide an additional emissions reduction of unknown amount.

COST EFFECTIVENESS

The cost effectiveness for this control measure is \$5,400 per ton of NO_X reduced.

OTHER IMPACTS

The enforcement of this control measure would require cooperation of the U.S. Coast Guard, use of radar observations, and surveillances at port locations and possibly from helicopters. Vessels would be delayed an average of 30 minutes approaching and leaving port. This should not cause any major impacts since vessels remain in District waters an average of 39 hours to unload or load cargo and 15 hours when bunkering only (Halberg, 1984).

This control measure will also conserve energy and reduce attendant SO_X and PM emissions. SO_X emissions are primarily addressed in Control Measure #88-I-5, "Limit on Sulfur Content of Marine Fuel Oils".

REFERENCES

Callahan, Pat. 1984. Poten and Partners. Personal communication with Larry Irwin, September 1987.

Halberg, Earl D. 1984. Area Source Methodology for Emissions from the Combustion of Fuels by Seagoing Vessels in the SCAQMD Territorial Waters and Harbors. SCAQMD Engineering Div. Report. July 1984.

South Coast Air Quality Management District. 1982. Final Air Quality Management Plan, Appendix VII-A, Measure G5. El Monte, CA. October 1982.

Windelev, Claus. 1987. MAN GHH Corp. Personal Communication with Larry Irwin, September 1987.

OF MARINE FUEL OILS [SO_X]

SUMMARY

Source Category: Marine Vessels.

Control Methods: Reduce Sulfur Content of Fuel; Electrification

of Berthing Facilities; Scrubbers.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------|------------------|------------------|------------------|
| SO _x Inventory | 23.5 | 27.0 | 28.0 |
| SO _x Reduction | | 16.2 | 16.8 |

Control Cost: Approximately \$3,000 Per Ton of $$50_X$.

Other Impacts: Potential Increase in Hazardous Wastes.

DESCRIPTION OF SOURCE CATEGORY

Background

Marine vessels consist of tanker and (dry-)cargo steamships and motorships, both foreign and domestic. Motorships use diesel engines and steamships use turbine engines to provide power for maneuvering, cruising, and berthing operations. The exhaust from these engines contains SO_X emissions. The amount of SO_X is a function of the concentration of sulfur in the fuel and the amount of fuel burned.

The three major types of petroleum based fuels that are burned in marine vessels are Bunker C fuel oil, intermediate bunker fuel oil (IBF), and marine diesel. Bunker C is a residual fuel that remains after lighter, more valuable products have been removed during refining processes. Intermediate bunker fuel is either a residual product with a naturally low Intermediate bunker C with a small amount of distillate fuel added to lower viscosity. Diesel fuel is a light distillate of crude oil.

The type of ship and mode of operation determine which of these three fuels is burned. The sulfur content varies significantly, depending on both the type of fuel and where the fuel is obtained, as shown below (CARB, 1984).

| Fuel Type/Origin | Sulfur Content Average | (Weight Percent) Range |
|---|---------------------------|----------------------------|
| Marine Diesel/California Marine Diesel/Foreign | 0.3 1.25 | 0.1 - 1.0 |
| Bunker C & IBF/California Bunker C & IBF/Foreign | 1.6 | 0.65 - 2.90 0.41 - 5.25 |

Generally, IBF and distillate fuels are used for maneuvering and docking, while residual fuel is adequate for cruising. However, there is a current trend to build ships that can operate solely on residual fuels (Windeley, 1987).

Marine vessels account for about 27 percent of the SO_X emissions from mobile sources. In 1983 domestic tanker steamships and foreign cargo motorships accounted for about 82 percent of both the commercial ships arriving in the District, and the SO_X emissions from all harbored commercial ship operations (Halberg, 1984). However, domestic tanker steamships alone comprised 14 percent those arrivals and generated about 39 percent of the SO_X emissions. The main reasons for this are: (1) steamships use residual fuel, while about half of the motorships used distillate fuel; (2) a steam turbine engine requires about 50 percent more fuel than a diesel engine (CARB, 1984); and (3) tankers use residual fuels to generate on-board power for pumping cargo and ballast water, whereas dry-cargo ships use dockside power for loading and unloading.

Regulatory History

This control measure was originally titled "Domestic Tanker Steamships". However, foreign cargo motorships generate an equal or larger portion of $SO_{\mathbf{x}}$ emissions in this District.

SO_x emissions from marine vessels are relatively uncontrolled and are only subject to one source specific rule, District Rule 1116.1, which requires lighter vessels to burn only fuel containing 0.5 weight percent (or less) sulfur. Lightering operations, normally conducted by tugboats pulling barges, comprised 5 percent and 2 percent of the commercial marine vessel arrivals in 1979 and 1983, respectively (CARB, 1984; and Halberg, 1984). In comparison, land-based sources have been controlled for some time by an extensive set of rules dating back to 1977. District Rule 431.2 (limiting fuels to between 0.05 and 0.5 percent sulfur) currently exempts ships.

In addition, under Regulation XIII, the District currently requires new berthing facilities to limit the amount of sulfur to 0.25 percent by weight in bunker fuels, and to 0.1 percent by weight in distillate fuels (in ships using their facilities). The Bay Area AQMD, in their Regulation 9, Rule 1,

limit the weight of sulfur allowed in all marine fuel to 3.34 percent (2000 ppm).

The District's Proposed Rule 1165 (electrification), primarily for the control of NO_{X} , will prohibit motorships from operating diesel engines while at berth. It will not apply to steamships in deference to Coast Guard regulations. (Their warm-ups are too slow for an emergency port evacuation.) Although this rule would reduce marine vessel NO_{X} emissions by about 50 percent, it would reduce their SO_{X} emissions by only 25 percent. This is because present-day motorships often operate on low-sulfur distillate fuels, while steamships normally operate on residual fuels. If adopted, this rule will probably not be in effect before 1992.

Control Measure #88-I-4, "Control of Emissions from Marine Diesel Operations", will augment this control measure by providing ${\rm NO}_{\rm X}$ emission controls.

PROPOSED METHOD OF CONTROL

 ${\rm SO}_{\rm X}$ emissions can be controlled by switching to alternative low-sulfur fuels; by electrification; or by add-on emission controls.

Low-Sulfur Fuels

SO emissions from marine vessels could be reduced by extending the low-sulfur fuel standards of District Rules 431.2 and 1116.1 and Regulation XIII to all other ships that berth at District ports. This approach is likely to be the most direct, cost-effective, and technically feasible way to reduce $\rm SO_{\chi}$ emissions. A sulfur limit of 0.5 percent by weight applied to all commecial vessels would reduce $\rm SO_{2}$ emissions 70 percent (assuming an overall weighted average of about 1.67 percent sulfur). Applied to domestic tanker steamships and foreign cargo motorships, this control would reduce $\rm SO_{2}$ emissions 58 percent; and its application to only domestic tanker steamships would reduce $\rm SO_{2}$ emissions 28 percent (Halberg, 1984).

Electrification

Another method under consideration (primarily for the control of $\mathrm{NO}_{\mathrm{X}})$ is electrification of berthing facilities, eliminating the need to run the ships engines while docked. Although 60 percent of the SO_2 emissions occur at berthing, this control measure would only reduce the total SO_2 emissions by about 25 percent (Halberg, 1984), since steamships would be exempt by Coast Guard requirements. This would also not reduce emissions while the ships were maneuvering or cruising in the port area. Therefore, the overall emission reductions would not be as great as by limiting the sulfur content of the fuel.

Scrubbers

Scrubbers are widely used in North America, Europe, and Japan to control SO₂ emissions from power plants, steam generators, and other combustion equipment (CARB, 1984). Wet-chemical scrubbers require large complex ancillary equipment and disposal of spent scrubbing solution.

Tankers commonly use water scrubbers to remove SO₂ from inert gas drawn from the ship's exhaust, which is then used to replace volatile ROG left in cargo tanks after unloading and deballasting operations. The sea is used for disposal of scrubbing water. These systems are presently designed to handle only 10 percent of full-load exhaust. Operation of inert gas scrubbers during maneuvering and berthing would require an engineering design change from present scrubber systems. However, inert gas scrubbers remove in excess of 90 percent of the SO₂.

EMISSIONS REDUCTION

Marine vessel operations which could be affected by this measure accounted for approximately 23.5 tons of SO_{χ} per day in 1985. Emission estimates for 2000 and 2010 are 27.0 and 28.0 tons per day, respectively.

Depending on the approach adopted the implementation of this control measure should provide a 25 to 90 percent emissions reduction, averaged about 16.2 tons per day in 2000, and 16.8 tons per day in 2010.

Ships that pass through District Coastal Waters, but do not enter the LA/LB Harbors, are not included in this emissions inventory as no such records are kept.

COST EFFECTIVENESS

The cost effectiveness of this measure is dependent on a number of factors. Within the California Coastal Waters, these include the number of annual visits a ship makes, the duration per visit and the percentage of sulfur currently present in the fuel burned by the ship. On an average, switching to low-sulfur fuel is estimated to hav a cost effectiveness of \$3,000 per ton of SO_X reduced (CARB, 1984). Higher cost impacts would be expected for the other two control approaches, based on preliminary analysis.

OTHER IMPACTS

Enforcement of this control measure could be readily accomplished by dockside spot checks, review of shipboard logs and records, and inspection of fuel receipts. The disposal of scrubbing water may have a negative impact on coastal waters.

REFERENCES

California Air Resources Board. 1984. "Report to the California Legislature on Air Pollutant Emissions from Marine Vessels." Vol. 1. July 1984.

Halberg, Earl D. 1984. <u>Area Source Methodology for Emissions from the Combustion of Fuels by Seagoing Vessels in the SCAQMD Territorial Waters and Harbors</u>. SCAQMD Engineering Division. Report. July 1984.

Windelev, Claus. 1987. MAN GHH Corp. Personal communication with Larry Irwin, September 1987.

CONTROL OF EMISSIONS FROM PLEASURE BOAT [ROG, NO.]

SUMMARY

Source Category: Pleasure Craft

Control Methods: Engine Modifications: Catalysts

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-----------------------------------|------------------|------------------|------------------|
| ROG Inventory | 23.2 | 35.3 | 41.3 |
| ROG Reduction | | 2.2 | 24.8 |
| NO_X Inventory NO_X Reduction | 4.6 | 6.3 3.8 | 7.1 4.3 |
| CO Inventory | 99.7 | 148.0 | 172.0 |
| CO Reduction | | 88.8 | 103.2 |

Control Cost: \$4,400 (2 stroke engines) Per Ton of ROG

\$37,100 (4 stroke engines) Per Ton of ROG

Other Impacts: None

DESCRIPTION OF SOURCE CATEGORY

Background

Outboard engines account for about 60 percent of the pleasure craft marketed in California (DMV, 1986). These outboards use predominantly 2stroke gasoline engines. Inboard/outboard (I/O) or "stern drive" systems are used in 20 percent of the boat population. These systems use inboard gasoline engines with a drivetrain/propeller system mounted on the stern of An additional 20 percent of the pleasure craft population utilize inboard engines which power propellers via driveshafts. Automotive engines are used almost exclusively in both stern drive and inboard systems.

The use of outboard or inboard systems is strongly dependent on boat size. The size, weight and cost advantage of outboards make them the engine of choice for the smallest boats. Inboards are more popular in the larger pleasure craft.

The distribution of boat usage in the South Coast Air Basin is estimated as follows:

Distribution of Boat Usage Patterns by Method of Propulsion in the South Coast Air Basin in 1977 (DMV, 1986; Austin, 1986)

| Method of Propulsion | Registrations | Percent of Fleet | Usage <u>Coastal</u> | (%) <u>Lakes</u> |
|-------------------------|---------------|---------------------|-------------------------|---------------------|
| Inboard | 44,499 | 25 | 63.8 | 36.2 |
| Outboard | 103,144 | 57 | 34.5 | 65.5 |
| Other | 32,068 | 18 | 49.4 | 50.6 |

Outboards are used on over 57 percent of the registered fleet. These boats are easily trailered and are generally unsuited for use in the deep swells occurring in coastal waters. Therefore, approximately two thirds of outboard usage occurs on lakes while only one third occurs in coastal areas.

Inboards, the next largest category, are used on 25 percent of the registered fleet. The inboard population is skewed toward larger boats, which offer more stability and can be used in coastal areas. They are generally more difficult to trailer. Therefore, they are mostly used, approximately 64 percent, in the coastal areas where a wider range of operating conditions are available.

The final category of boats, "other", makes up less than 20 percent of the registered fleet. A broad range of boat designs fall into this category, including sailboats, auxiliary sail, rowboat, canoe, and other varieties of outboard-powered craft.

With limited exceptions, the outboard motors are 2-cycle engines and the inboard motors are 4-cycle. There are substantial differences between 2-cycle and 4-cycle gasoline engines using "pre-mixed charge" (i.e., carburetors or upstream fuel injection). Two-cycle engines are smaller, lighter, simpler, and less expensive than 4-cycle. They are also less fuel-efficient, and have higher ROG and CO and lower NO $_{\rm X}$ emissions than the 4-cycle engines. Because of these differences, separate standards for each type of engine are recommended.

Regulatory History

Measure N14 of the 1982 AQMP Revision (SCAQMD, 1982) proposed the establishment of exhaust emission standards for all recreational craft

powered by internal combustion engines. Since no implementation action has been taken, Measure N18 is herein being reintroduced.

PROPOSED METHOD OF CONTROL

This control measure would establish emission standards for new 2-stroke and 4-stroke pleasure craft engines sold in the Basin. Current emission rates and proposed standards for each type of engine are as follows:

Pleasure Craft Emission Factors and Proposed Standards (1bs/1000 gallons)

| | ROG | <u>co</u> |
|--------------------------------------|------|-----------|
| 2-Cycle Outboards | | |
| Current Emission Factor (Hare, 1973) | 1100 | 3300 |
| Proposed Standard (60% Control) | 440 | 1320 |
| 4-Cycle Inboards | | |
| Current Emission Factor (U.S. EPA) | 86 | 1240 |
| Proposed Standard (60% Control) | 34 | 500 |

These proposed standards represent a level of control equivalent to that established for 1987-model-year motorcycles by the ARB in April, 1983. This measure would be implemented with (1) a mix of engine modifications, electronic controls, and catalytic exhaust treatment, similar to automotive and motorcycle emission control systems; and/or (2) the use of methanol fuel. Further analysis is required to confirm the technical feasibility of the proposed methods.

EMISSIONS REDUCTION

Potential emission reductions are expected to be about 95 percent of the current emission inventory for catalytic controls, and about 50 percent for engine modifications. The use of methanol fuel would reduce ROG emissions by about 50 percent. The overall effectiveness of this measure is estimated to be about 60 percent control.

Pleasure craft emissions and potential reductions in the Basin are estimated as follows. The projected growth for this source category appears to be relatively high and therefore, is subject to further study.

| Emissions: (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|---------------------------------------|------------------|------------------|------------------|
| ROG Inventory | 23.2 | 35.3 | 41.3 |
| ROG Reduction | | 2.2 | 24.8 |
| NO_{X} Inventory NO_{X} Reduction | 4.6 | 6.3 3.8 | 7.1 4.3 |
| CO Inventory | 99.7 | 148.0 | 172.0 |
| CO Reduction | | 88.8 | 103.2 |

COST EFFECTIVENESS

The cost effectiveness associated with the implementation of the proposed control measures would be \$4,400 per ton of ROG for two-stroke engines and \$37,100 per ton of ROG fot four-stroke engines. As indicated earlier, when additional data becomes available due to more estensive study in the future, the control cost will be re-evaluated.

OTHER IMPACTS

No adverse impacts are expected from implementation of the proposed control measure.

REFERENCES

Austin, Thomas C. 1986. Sierra Research. Letter to Paul Wuebben, July 22, 1986.

Department of Motor Vehicles, State of California. 1986. <u>Total Vessel</u> Registrations By County as of 27 Dec 1985." January 8, 1986.

Hare, C.T., Springer, K.J. <u>Exhaust Emissions from Uncontrolled Vehicles</u> and Related Equipment Using Internal Combustion Engines; Final Report, Part 2, Outboard Motors. Report AR-850, Southwest Research Institute. January 1973.

U.S. Environmental Protection Agency, Office of Air, Noise and Radiation, Office of Air Quality Planning and Standards. Supplement No. 15 for Compilation of Air Pollutant Emission Factors. Third Edition. January 1984.

CONTROL OF EMISSIONS FROM SWITCHING LOCOMOTIVES [ALL POLLUTANTS]

Source Category: Trains

Control Methods: Modification of Fuel Use; Modification of Engines;

| Emissions (Tons/Day) | <u>Year 1985</u> | <u>Year 2000</u> | <u>Year 2010</u> |
|-------------------------|------------------|------------------|------------------|
| ROG Inventory | 5.5 | 8.4 | 9.9 |
| ROG Reduction | | NA | NA |
| NOx Inventory | 21.0 | 32.5 | 38.8 |
| NOx Reduction | | NA | NA |
| SOx Inventory | 2.4 | 3.6 | 4.2 |
| SOx Reduction | | NA | NA |
| PM Inventory | 1.3 | 1.9 | 2.2 |
| PM Reduction | | NA | NA |
| CO Inventory | 9.8 | 15.1 | 17.9 |
| CO Reduction | | NA | NA |

Control Cost: Dependendent Upon Control Method Applied, Possible Cost Savings

DISCRIPTION OF SOURCE CATEGORY

Background

There are generically two types of locomotive diesel electric engines operation: (1) linehaul locomotives, and (2) switch and transfer locomotives. Operationally, locomotives are controlled by a throttle with eight distinct notch positions in addition to idle and dynamic braking settings. Switching and transfer locomotives typically operate in lower

throttle positions due to the slower speed conditions of urbanized areas. Linehaul locomotives operate at higher tonnages where higher throttle positions are necessary.

The horsepower ratings of locomotives range from a high of about 5,000 hp to under 1,000 hp. The higher power locomotives are usually used for line-haul purposes with the smaller locomotives used in switch and transfer operations. Generally, switch locomotives operate within a switchyard or terminal area, while transfer locomotives move rail cars between switchyards and are involved in branchline service where rail cars are delivered to or received from customers. Switch and transfer locomotives are typically smaller, lower power units. The Federal Railroad Association estimates that there are 208 switch and transfer locomotives and 339 linehaul locomotives in the South Coast Basin, all of which are diesel electric.

Regulatory History

There are three general approaches to reducing emissions from locomotives: (1) application of emission control technology; (2) use of cleaner fuels such as natural gas or methanol; (3) improvements in operating duty cycle. Section 40702 of the California Health and Safety Code prohibits the District from mandating specific designs of equipment or control methods. However, the District could establish generic emission standards for locomotives which could be implemented by any combination of these alternative control approaches.

Section 25301.1 of the Public Resource Code establishes the Locomotive Emission Advisory Committee to "..study the existing and proposed technologies that are economically feasible and practical for the industry to implement in order to contribute to a reduction of railroad locomotive emissions". This Advisory Committee must submit draft recommendations to the Governor and State Legislature by July 1, 1989.

Locomotive duty cycles have also been modified to reduce emissions. Historically, diesel locomotives have been allowed to idle when not in active service. Periods of standby idle were often extensive, as long as eight or more hours consecutively, with prolonged periods (48 hours or more) not uncommon. Engine shutdowns are now a standard feature of railroad fuel conservation policy during prolonged inactivity. Santa Fe Railroad is the only regional operator without a clear policy on fuel conservation locomotive shutdowns.

Newly designed locomotives in line haul service are being equipped with fuel conservation devices which allow locomotives to be isolated in a low idle fuel position while not in use for train power. Newer versions allow for a complete shut down of the diesel engine when not in use for train power. Additional effort are underway to improve flange lubrication which reduces rolling resistance allowing reduced fuel use and reduced emission.

PROPOSED METHOD OF CONTROL

Operating Cycle Fuel Conservation Changes

Require all operating railroads to implement the Railway Fuel and Operating Officers locomotive operating standards for fuel conservation within the South Coast Air Basin.

Engine Operation Changes

Control measure should be implemented by the application of alternative control techniques, such as electronic engine controls, exhaust gas recirculation, combustion chamber redesign, and engine fuel conservation controls. The generally lower engine speeds and more steady state operation of locomotives also may make particulate trap use feasible. Such traps are currently under development for heavy duty trucks and underground mining equipment.

The standards for particulate and NO_x emissions adopted by the EPA for urban buses and trucks reflect the wide range of work requirements (i.e., horsepower requirements) placed on heavy duty diesel engines. Locomotive engines, while 2-5 times larger than heavy duty engines, present quite similar engineering constraints from an emission control standpoint. Emission control techniques generally applicable to large diesel engines include: 1) modification of fuel injection timing, 2) modification of injector design, 3) exhaust gas recirculation, and 4) water injection.

Alternate Locomotive Fuels

Burlington Northern has successfully field tested a natural gas fired locomotive pulling 29 freight cars. They have also recently demonstrated the use of up to 44% methanol/diesel mixtures in conjunction with ARCO Petroleum Products Company. Methanol use in urban transit buses has been found to virtually eliminate particulate emissions while reducing NO_x by up to 50% at the same time. It is expected that similar emission results can be achieved by the use of alternative clean fuels in locomotive diesels. This is dependent upon successful development of alternate fuels technology for locomotives.

The recommendation in this measure would apply to rebuilt and re-engined locomotives as well as to new locomotives. Retrofit standards may also be feasible with the same control options. Nationally, 75% of the locomotives were built prior to 1975. There are currently only two manufacturers of locomotives in the US: General Electric (G.E.) and Electro Motive Division of General Motors (EMD).

EMISSIONS REDUCTION

Locomotives are estimated to account for the following emissions in 1985, 2000 and 2010:

| | ROG | NO_X | so _x | PM | CO |
|------|-----|--------|-----------------|-----|------|
| 1985 | 5.5 | 21.0 | 2.4 | 1.3 | 9.8 |
| 2000 | 8.4 | 32.5 | 3.6 | 1.9 | 15.1 |
| 2020 | 9.9 | 38.8 | 4.2 | 2.2 | 17.9 |

Emission reductions year 2000, with this measure in place and the rail electrification measure with 50% electrification. This measure based upon methanol fuel reduces the remaining inventory by the following amounts:

| ROG | NOX | SO _X | PM | CO |
|-----|-----|-----------------|-----|-----|
| 4.2 | 1.3 | 0.8 | 0.1 | 0.5 |

Emission reductions year 2010, with this measure in place and the rail electrification measure at 90% electrification. This measure, based upon methanol fuel, reduces the remaining inventory by the following amounts:

| ROG | NOX | SO _X | PM | CO |
|-----|-----|-----------------|-----|----|
| 1.0 | 1.5 | 0.4 | 0.2 | 0 |

COST EFFECTIVENESS

Implementation of the proposed controls would impose some costs on operating railroads. Costs would depend upon the degree of implementation required. Some significant cost savings could result from fuel savings. Possible significant increases in fuel cost due to use of alternative fuels. Railroad electrification will also affect the degree of implementation of this measure.

OTHER IMPACTS

This control measure will be impacted by the degree to which line haul operations of railroads are electrified in the Basin. Electrification of all line haul operations by 2010, as proposed by SCAG in Appendix IV-G of the 1988 AQMP, would eliminate 90% of the current locomotive emissions in the Basin. The remaining low use and industrial lines would then be expected to operate exclusively on alternative fuels.

REFERENCES

U.S. Department of Transportation. 1973. "Railroads and Air Pollution: A Perspective". Report No. FRA-RT-73-33. 1973.

Reed, William. 1986. Research and Development Department, Burlington Northern Railroad, Overland Park, Kansas. Personal communication with Paul Wuebben, July 1986.

Reed, William. 1983. "Natural Gas as an alternative Fuel for Locomotives".
Burlington Northern Railroad. 1983

Reed, William. 1984. "No. 2 Diesel Fuel-Methanol Emulsion Test with Locomotive on Load Box". Burlington Northern Railroad. 1984.

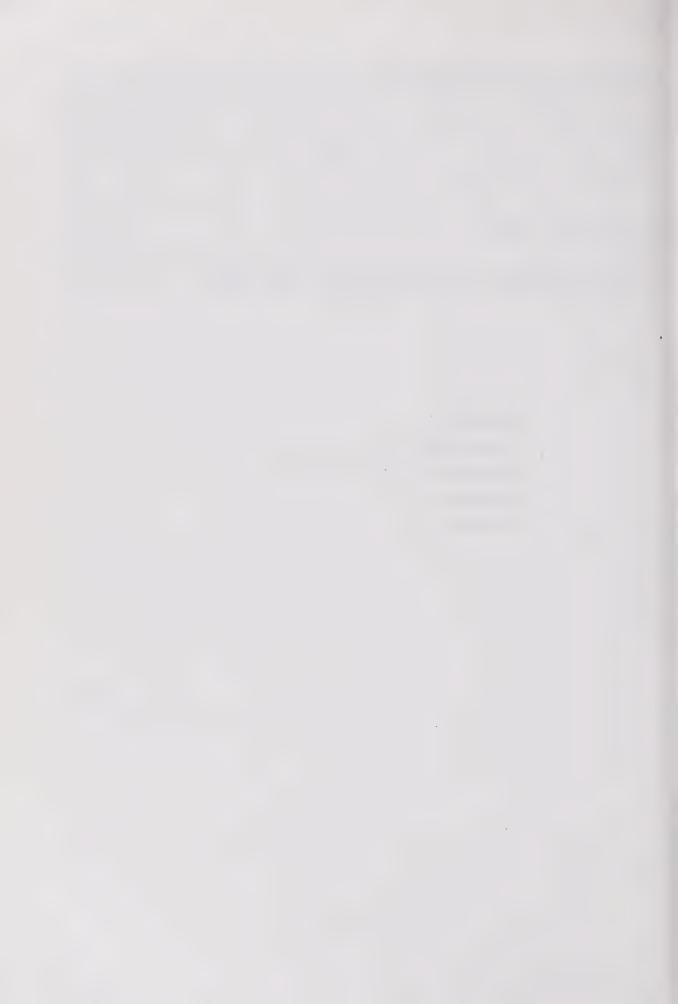
The Railway Fuel and Operating Officers Association. 1987. "Fuel Conservation From An Operating Viewpoint". 1987.

Baker, Robert. 1988 Southern Pacific Transportation Company. Personnal communication with Robert Huddy, 1988.

PART TWO

TIER TWO CONTROL MEASURES

Introduction
Transportation Sector
Surface Coating and Solvent Use
Stationary Sources
Summary



INTRODUCTION

After all currently known technologies are applied to existing emission sources, additional emission reductions are still required in order to meet the federal and state air quality standards. Tier II control measures were developed to provide further emission reductions and are directed at demonstrated technologies which require further advancement or improvements which can reasonably be expected to occur within the planning time frame. In some cases, new technological applications not presently on the market are required. Full implementation of Tier II measures is scheduled for completion by 1998. Regulatory intervention is employed whenever necessary to expedite the process. Tier II measures emphasize:

Extending current technological applications beyond the levels traditionally pursued.

Introducing active regulatory intervention through technology-forcing standards or emission charges.

Developing strong enforceable public and private commitments for the required implementation actions.

Table II-1 summarizes the proposed Tier II control measures and their goals. These measures are mostly an extension of Tier I control measures through more aggressive penetration or through regulatory intervention when voluntary technological advancement falls behind the specified targets. The following sections briefly describe individual measures to attain the specific goals. When detailed technical information can be found in other appendices, it is referenced to avoid repetition.

TABLE II-1 TIER II CONTROL GOALS

| SECTOR | APPROACH | GOAL |
|------------------------------------|--|---|
| TRANSPORTATION | REDUCED VEHICLE USAGE | REDUCTION OF VMT TO 1985 LEVELS |
| | CLEAN FUEL PASSENGER VEHICLES | 40% PENETRATION |
| | CLEAN FUEL FREIGHT VEHICLES | 70% PENETRATION |
| | CLEAN FUEL TRANSIT BUSES | 100% PENETRATION |
| | STRICTER EMISSIONS STANDARDS/CLEAN FUELS FOR OFF-ROAD VEHICLES | 50% REDUCTION OF REMAINING EMISSIONS AFTER TIER I |
| SURFACE COATING AND SOLVENT USE | LOW ROG CONSUMER PRODUCTS | 50% REDUCTION OF REMAINING EMISSIONS AFTER TIER I |
| | LOW ROG COATING APPLICATIONS | 50% REDUCTION OF REMAINING EMISSIONS AFTER TIER I |
| STATIONARY SOURCES | EMISSION CHARGES | EMISSION MINIMIZATION |
| | MORE STRINGENT CONTROL TECHNOLOGY | EMISSION MINIMIZATION |

TRANSPORTATION SECTOR

Transportation control measures within Tier II focus on maintaining vehicle usage at the 1985 levels to cope with significant projected growth in population, and increasing the penetration of electrically powered and alternatively fueled vehicles. These strategies consist of broadening Tier I approaches such as transportation and land use controls, growth management, and rideshare programs, among others. In addition, control of off-road vehicles will be needed to achieve Tier II emission reduction goals.

Reductions in Vehicle Trips and Vehicle Miles Traveled

Description

As the population within the South Coast Air Basin continues to grow, Tier I measures to decrease the number of vehicle miles traveled and the number of vehicle trips will need to be enhanced to attain Tier II air quality goals for the transportation sector. Such measures include expanded employer rideshare/transit use incentives, telecommuting, parking management, and local growth management. Limitations on the number of gasoline and diesel-powered vehicles registered in the Basin will further decrease the use of these light-duty passenger vehicles. Transit and traffic flow improvements coupled with highway capacity enhancements and construction of high-occupancy vehicle lanes will facilitate achievement of Tier II goals.

The travel behavior of medium- and heavy-duty trucks will also be affected. Measures focusing on relief of nonrecurrent congestion and diversion of goods from truck to rail will act to increase the efficiency of trucking operations thereby reducing the number of vehicle miles traveled and vehicle trips, as well as increasing the speed of all vehicles on the highway.

Implementation Actions

Tier I control measures will be strengthened to meet Tier II transportation sector goals. Legislation at both the state and federal levels will be required to secure funding for construction of additional

infrastructure, as well as to enable the District and other agencies to promulgate additional Tier II control measures.

Through a combination of incentives and regulatory intervention, more people will begin to use public transportation, rideshare, and increase their use of alternative fuels and electric powered vehicles. To ensure that the measures actually achieve the reduction in vehicle use, a monitoring program will be initiated in 1991. By 1993, the basic regulatory intervention will be in place. Beginning in 1990, transportation infrastructure improvements such as the 105 Freeway, Metrorail, and light and heavy-rail corridors will come into operation.

Alternative Fuels/Electrification for Mobile Sources

Description

Implementation of alternative fuel technologies developed as a result of the District's Clean Fuels Program is one of the Tier II transportation sector goals. The Clean Fuels Program is a \$30.4 million program which began in fiscal year 1988 and is scheduled to continue until the end of 1993. The participation of ARB, CEC, and other agencies is needed to accomplished these goals. Its main purpose is to expedite commercialization of innovative technologies as replacements for conventional petroleum-based fuels. These alternatives include combustion fuels such as, but not limited to, methanol and compressed natural gas, and electrification using storage batteries and fuel cells.

Funding for the Clean Fuels Program is intended to promote research and development efforts and to sponsor joint demonstration projects with manufacturers, governmental agencies, and major fuel consumers. Current efforts include working with industrial organizations to develop and fund several joint projects.

Attainment of Tier II goals will require that forty percent of the passenger vehicle fleet be powered by electricity or use alternative fuels. Significant efforts to bring electric vehicles into commercial production are currently underway. Electrification of highways to provide a continuous source of power will require significant

advances in technology to be applied on a large-scale basis. A more detailed discussion on electric vehicle technology is contained in Appendix IV-B and Appendix IV-G.

Tier II controls also call for 70 percent of freight vehicles to be powered by alternative fuels by 1998. All diesel buses will be required to be electrified or use alternative fuels.

Implementation Actions

The Clean Fuels Program includes alternative fuel demonstrations funded jointly by government and industry. For mobile sources, nineteen demonstration projects are proposed which involve vehicles powered by methanol, electricity, or compressed natural gas. Methanol related projects include vanpool fleet demonstration, transit bus demonstration, truck retrofit, fuel additive improvements, and fuel infrastructure development. Fleet demonstration of advanced prototypes are planned for electric vehicles, as are projects which involve advanced prototypes with internal combustion engines and fuel cell-electric vehicle hybrids. Finally, compressed natural gas projects include current and advanced prototype bus and locomotive switch engine demonstrations.

Other key components in the Clean Fuels Program are rules which require demonstration projects, mandatory purchase of electrified or alternative fueled vehicles by public and commercial fleet operators, and fuel infrastructure development to promote alternative fuel use.

Implementation of the key elements of the Clean Fuels Program during the next five years will form a foundation to facilitate commercialization of alternative fuel technologies. To achieve Tier II objectives for transportation sources by 1998, measures to accelerate penetration of electrified/alternately fueled vehicles into the vehicle fleet will be required. In addition, technological innovations gained from the research and development aspects of the program will be used to promote the change to alternative fuels in heavy-duty vehicles. The knowledge gained both through the Clean Fuels Program and through other research efforts will help to develop additional technologies that will allow us to achieve Tier II emission reduction goals.

Off-Road Vehicles

Description

Tier I control measures which affect off-road vehicles apply emission control technology (1) developed as a result of state and federal on-road motor vehicle emissions control programs or (2) in use in other locations. Tier II calls for 50 percent of off-road vehicles to use alternative fuels. These measures would apply emission standards to railroad switch engines, non-electrified linehaul locomotives, and forklifts, for which no emission control technology was considered available in Tier I. The Tier II measures would also apply stricter standards to non-farm equipment and off-road vehicles where new emission standards were included in Tier I control measures. Farm equipment is not included because farming in the Basin is expected to be virtually eliminated by 2007 due to urbanization.

Implementation Actions

The ARB has authority to regulate self-propelled vehicles which may operate on a public highway. This authority is interpreted to include off-road vehicles operating on tires such as off-road motocycles, forklifts, small construction equipment. The remaining vehicles, railroad locomotives, boats and ships, and aircraft are under the District's authority. Tier II control measures for off-road motocycles, forklifts, and construction equipment are not in ARB's Post-87 Motor Vehicle Control Program (Appendix IV-F), but are logical extensions of emission control technology presently in place or under development by ARB. As the technology becomes available, regulating of these sources can be expected to be included in ARB's program. Tier II control measures for boats and railroad locomotives are included in the District's Clean Fuels Program as described in the preceeding section.

Surface Coating and Solvent Use

Tier II controls applied to the solvent use category are based on the use of alternative methods or processes in coating and solvent cleaning operations,

and further technological advancement in product and propellant reformulation for consumer products.

Solvent and Coating Applications

Description

ROG emissions from solvent and coating applications are targeted to be reduced 50 percent under Tier II strategies through the use of higher transfer efficiency application methods and alternative coating technologies. These technologies were introduced in several categories as Tier I strategies and require advancement of known technology to penetrate the portion of the market required to achieve the Tier II emission reductions.

The use of higher transfer efficiency applications such as turbo spray or electrostatic spray can reduce coating consumption as more of the coating material strikes the target and less overspray results. Higher transfer efficiency spray equipment is used in a number of coating operations. With improved technology and adoption of minimum transfer efficiency requirements by the District, the use of these methods can become more widespread throughout the coating industry.

The application of coatings by automated or robotic methods in conjunction with more efficient spray equipment can further increase transfer efficiency. These techniques can be adopted for use on assembly lines or for continuous coating of similar parts. Automated methods are currently used in a number of coating processes, including auto assembly and appliance coating operations. Adaptation of robotic or automated technology to other production line coating operations, such as metal parts and products, wood furniture, and aerospace assembly and component coating, can provide a portion of the required Tier II emission reductions.

Alternative non-solvent based coating products or processes, such as powder, aqueous powder, and radiation-curable coating systems, can be implemented to virtually eliminate ROG emissions from coating operations. Powder coating is currently being used in portions of the

automobile, large appliance and heavy equipment coating industries. Further advances in technology can provide a higher quality finish and may be applied at lower temperatures to plastic and wood substrates. Radiation-curable coatings are in use in a number of operations including wood flatstock, graphic arts, printing, plastic and metal coating and adhesive industries. This non-ROG emitting, more energy efficient technology can become more widely used as product suitability problems are resolved.

Implementation of alternative non-solvent based technologies can provide a portion of the Tier II ROG reductions. Crossover of these technologies into other solvent use categories offers the opportunity for industry-wide implementation as Tier III control strategies. A technical description of the above mentioned technological applications can be found in the Tier III Solvent Future Report, Chapter III (Appendix IV-C).

Implementation Actions

In order to facilitate the complete adoption of the Tier II control measures and achievement of the associated emission reduction goals within ten years, a number of implementation actions are necessary. Within the year following AQMP adoption, a cooperative effort among the District, ARB, product manufacturers, and end users will be established to fully assess the constraints and options involved with implementation of the Tier II controls.

During the second year, implementation action requires the development of a basin-wide outreach and monitoring program. The program will be aimed at disseminating information and educating business owners and operators who use solvents that alternative or improved technologies can be successfully substituted for reactive solvent processes or products. This program will exist throughout the duration of Tier I, II and III implementation. It will also provide additional technical consultation and evaluation through a cooperative effort among District, ARB and/or EPA staff. Another action to begin in the second year following plan adoption is development by the District, and approval by the State Legislature, of a policy regarding tax incentives or emission charges to enhance or encourage the timely adoption of control measures.

Implementation of current technology able to achieve Tier I emission reduction goals is slated for the five years following plan adoption. Research and development activities to advance known technology, including alternative methods, reformulated products, and more efficient application methods are scheduled to begin upon identification of constraints and technological options available to sources within the coating and solvent use category. Such technologies are intended to achieve the Tier II emission reduction goals of 50 percent of remaining ROG emissions, after full implementation.

Research and development activities will continue, focusing on technological breakthroughs required to achieve the Tier II emission reduction goals by 2007. Field testing and demonstration of newly developed or refined products or processes is scheduled to begin as early as the third year following plan adoption. This effort will continue until Tier III implementation is completed.

Consumer Products

Description

Reformulation of consumer products with less photochemically reactive solvents and development of alternative propellant or dispensing mechanisms are the methods relied upon to reduce ROG emissions from consumer products. Further development and widespread application of these control techniques can greatly reduce ROG emission from the diverse consumer products category.

Implementation Actions

The implementation of a statewide or local enforcement program can facilitate development and commercialization of compliance consumer products. Emission charges can be placed upon consumer products based on ROG content to provide incentive for further reduction to achieve the Tier II emission reduction goals of 50 percent of remaining ROG emissions after Tier I. Outreach programs to arouse public awareness are also necessary to enhance the marketability of the newly formulated or packaged products. These

activities can be carried out in conjunction with those specified for the solvent and coating applications.

STATIONARY SOURCES

CONTROL OF EMISSIONS WITH EXPORT FEES

Description

Petroleum refining is a major source of emissions in the Basin. This industry is located primarily along the coast which provides access for ship deliveries. Petroleum refining facilities in the Basin serve demand originating both within and outside Southern California. Approximately 20 percent of Basin refinery products are exported outside Southern California. This measure proposes that emission fees be placed on petroleum refining products which are manufactured in the Basin and exported for use outside of Southern California.

Implementation

The District would be the agency responsible for collection of these fees. This control measure would encourage companies who are using pipelines to transport petroleum products out of the Southern California area to relocate and/or construct new refining facilities in areas outside of the Basin. Companies who are not able to relocate their facilities outside the Basin or to discontinue production of products which are used outside of Southern California would have to pay an emission fee.

The emission fee would be tied to the amount of emissions produced from refining these products which are exported outside of Southern California. Information would also be gathered on the price differences of the end products inside and outside the Basin in order to accurately generate the correct emission fee. The fee should be high enough to ensure that petroleum production will decrease to

facilitate air quality improvement. Additional enforcement and monitoring would be required.

The District would need to finalize the level of the charge and all necessary research by 1992 in order to seek authority for adoption of this control measure by 1993.

Control of Construction Dust Through Use of Emission Fees

Description

Dust emissions are generated by such activities as land clearing, blasting, ground excavation, cut and fill operations, and travel on the site and on access roads. Wind and water erosion, heavy equipment tires, and trucks transport the soil onto sidewalks and roadway where pedestrians and vehicles generate fugitive dust resuspension. These PM emission vary with the level of activity, specific operation, type of soil, and weather conditions.

Presently, counties and municipalities within the South Coast Air Basin require some form of dust control at construction sites. Current types of dust control are watering at sites, use of a chemical soil binder, or constructed wind barriers. Watering is the most frequent type of control method used due to its availability at construction sites. Although each county and/or city has its own enforcement division, dust abatement requirements are only enforced when a nuisance complaint is made. This measure proposes that emission fees be charged to developers who produce PM emissions during construction.

Implementation Actions

The agency issuing building permits would be the lead agency responsible for the implementation, monitoring, and enforcement of the fees. When obtaining a building permit, the lead agency would determine the amount of PM emissions which may occur at a construction site based on building plans, location, and amount of time required to construct the facility. The developer would then

have the option to mitigate the emissions or to pay a fee based on the emissions. Additional data is needed in this area.

The money collected from the emission charges could be used by the lead agency to assist developers with the financing of control equipment to reduce PM emission at construction sites.

The lead agency would need to finalize the level of the emission fee and to complete all necessary research by 1992 in order to seek authority for adoption of this control measure by 1993. The lead agency would also have to be granted the authority and assistance to enforce compliance of this measure.

Emission Charges

Description

Traditional technology-forcing regulations use available control technology to determine the emission control levels for selected processes in a group which are then applied uniformly to all the subject processes within the group. Although these regulations will force subject sources to comply with set standards, they may not offer incentives to these sources to go below such set standards.

Implementation of Tier II control measures require further advancement and improvement of demonstrated technology, and even new technology applications not presently on the market. Emission charges measures are introduced to facilitate the development of this technology, although they may not, by themselves, reduce emissions. The revenue from emission charges will flow back to subject sources as research funds for financing further development of the advanced technology.

Implementation

Emission charges will tie emission standards to the applicable control technology. For each emission charges control measure, there will be a threshold emission standard with which every subject source should

comply. In addition, a more stringent standard will be set up as the goal standard which will be tied to the control technology, intended for further development. Emission charges will be imposed on pollution-generating activities. Charges on a per emission unit basis will be indexed to the additional costs of moving into the intended control technology for further development. Sources which cannot comply with the goal standard will have to pay the charges for their excess emissions. Subject sources can choose either to comply with the goal standard or to pay the charges. This concept can be used for almost every source category.

Implementation of emission charges depends on legislative authority to use emission charges as an alternative control option. SB-151 requires the District to submit a draft of an emission charges rule to the State Legislature by September 1, 1988. The District will seek the authority to adopt this proposal to impose emission charges on pollution-producing activities.

Emission charges control measures will expedite the development of advanced technology, although they may not reduce emissions directly. Achievement of Tier II goals will depend upon the extent to which the advanced technology has been developed. Therefore, emission charges control measures should serve as a harbinger of intended Tier II technology-forcing control measures. As such, it is necessary to adopt emission charges control measures earlier than 1993, the intended adoption date for Tier II technology-forcing control measures.

SUMMARY

The additional emission reductions as a result of Tier II controls are shown in Table II-2. The combined reductions for Tier I and Tier II are presented in Table II-3.

TABLE II-2
TIER II EMISSION REDUCTIONS

| SOURCES | POLLUTANT (TONS/DAY) | | | | |
|----------------|----------------------|-----|-----|-----|------|
| | ROG | NOx | CO | ŚOx | PM |
| TRANSPORTATION | 15 | 90 | 443 | 11 | . 17 |
| STATIONARY | 170 | 33 | 23 | 7 | 494 |
| TOTAL | 185 | 123 | 466 | 18 | 511 |
| | | | | | |

TABLE II-3 CUMULATIVE EMISSION REDUCTIONS FROM TIERS I AND II MEASURES

| SOURCES | | POLLUTANT (TONS/DAY) | | | |
|----------------|-----|----------------------|------|-----|------|
| | ROG | NOx | CO | SOx | PM |
| TRANSPORTATION | 260 | 478 | 3021 | 27 | 57 |
| STATIONARY | 520 | 243 | 313 | 65 | 1227 |
| TOTAL | 780 | 721 | 3334 | 92 | 1284 |



